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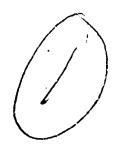
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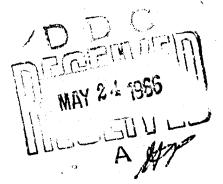


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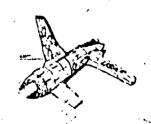
TAC MISSION FF857,

AIR COMBAT TACTICS EVALUATION

F-100 F-104 F-105 F-4C Vs MIG-15/17 TYPE A/C(F-86H)(4)

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FOREWORK

TAC directed the USAF Fighter Weapons School, Nellis AFB, Nevada, to conduct an evaluation to determine the most suitable offensive and defensive maneuvers for the F-100, F-104, F-105 and F-4C versus MIG 15/17 type aircraft.

Colonel James C. Hare, Commandant, Fighter Weapons School, was designated project officer. Authority for the conduct of the test was TAC message C-0054, 28 April 1965 (SECRET). This report is submitted in accordance with TACR 80-1.

Assistant project officers were designated for each type of participating aircraft. F-86H, F-104 and F-4C team commanders were so designated for their respective types of aircraft.

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F-105D - Capt Michael S. Muskat USAF FWS

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FINAL REPORT

AIR COMBAT TACTICS EVALUATION

TAC MISSION FF-857

26 APR - 7 MAY 1965

This report was prepared by personnel of the USAF Fighter Wesponz School, Nellis AFB, Nevada. Comments should be directed to Hq Tactical Air Command (DO) with info to USAF FWS.

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CAVFICANTIAL ABSTRACT

The objectives of the Evaluation (TAC Mission FF-857) were to determine the most suitable offensive and defensive maneuvers for the i-100, F-104, F-105 and F-4C versus MIG 15/17 type aircraft. Energy maneuverability diagrams were used to substantiate conclusions and i-commendations. Use of energy maneuverability concept for planning was limited; however, because necessary energy maneuverability diagrams were not available for the F-86H aircraft, which simulated the MIG 15/MIG 17 types.

It was determined that the F-100. F-104, F-105 and F-4C should avoid co-speed, high angle of attack engagements with the MIG 15/17 type aircraft. On the offensive, a speed advantage should be maintained. On the defensive, maneuvering in an attempt to cause an overshoot will probably be unsuccessful. Therefore, an attempt to disengage should be made by reducing the angle of attack and using max power to move out of the attacker's range, maneuvering as necessary to spoil a tracking solution until well outside gun and/or missile range.

Performance data obtained in this test is in agreement with data obtained from energy maneuverability diagrams.

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- 1. INTRODUCTION: In Southeast Asia our supersonic F-100s, F-105s and F-4s have engaged or been engaged by subsonic MIG 15s and MIG 17s. The results of these engagements indicate an urgent need to determine the most suitable offensive and defensive maneuvers to be employed against the MIG 15/17s. The F-100, F-104, F-105 and F-4C were evaluated in simulated air-to-air combat using the F-86H as MIG 15/17 comparable aircraft.
- 2. <u>DESCRIPTION OF TEST ITEMS</u>: Refer to flight handbooks for information on the following types of aircraft used in the test.
 - a. Three F-100Ds provided by the 4520th CCr Tng Wg.
 - b. Three F-104Cs provided by the 479th Tac Ftr Wg.
 - c. Five F-105D/Fs provided by the 4520th CCr Tng Wg.
 - d. Three F-4Cs provided by the 4453rd CCr Tng Wg.
- e. Five F-86Hs provided by the Maryland and the New York Air National Guard.

For purposes of the evaluation, all aircraft were considered to be equipped with 20mm cannon, either M-39 or M-61, and with AIM-9/R missiles. This assumption was made in view of pending F-4C gun installation.

- 3 <u>PURPOSE OF TEST</u>: To determine the best offensive and defensive maneuvers to be employed against MIG 15/17 type aircraft and to verify through flight test certain data and conclusions obtained from energy maneuverability diagrams.
- 4. OBJECTIVES OF TEST: The objectives of this evaluation were to determine the following:
 - a. Most suitable offensive maneuvers.

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- b. Most suitable defensive maneuvers.
- c. Most suitable element tactics.
- d. Verify certain energy maneuverability data.

5. CONCLUSIONS:

a. General:

- (1) If F-100, F-104, F-105 or F-4C cruising at .9 mach or below are engaged by MIG 15/17 type aircraft, executing .95 rach attacks from the rear hemisphere, the best course of action is to employ a maximum power acceleration to supersonic speed for separation rather than employing defensive maneuvers designed to force an overshoot.
- (2) If such attacks are detected within minimum separation range (3000-4000' for F-4C, 4000-5000' for F-104, 5000-7000' for F-100 and F-105), an accelerating diving spiral, max power escape is recommended.
- (3) If such attacks are detected at attacker gun fire range, a break followed immediately by the diving spiral must be attempted.
- (4) For offensive use during a maneuvering fight, the AIM-9/B is severely limited in that the launch capability is restricted by low angle off and G limitations.
- (5) Evaluation of TAC fighter maneuvering flight capabilities at low altitude (2000-15,000) was not analyzed due to the imposed 10,000 AGL minimum altitude restriction. Such capability is predicted by current energy maneuverability data to be greater than at higher altitudes.

(6) According to participating F-4C aircrews, opportunities were presented for employment of AIM-7 and particularly AIM-7E missiles; however, live testing against maneuvering targets is required immediately to verify predicted capabilities.

b. F-100D:

- (1) Defensive employment of descending hard turns is recommended to defeat AIM-9B type missile attacks. F-100 mach should be maintained at .9 or higher.
- (2) Defensive employment of breaks is recommended to defeat gun attacks detected within or slightly outside gun firing range.

 Breaks should be continued to a diving separation maneuver if an offensive position is not achieved by a break maneuver.
- (3) Use of high G rolls or scissors maneuvers to gain an offensive position is not recommended against F-86H type aircraft.
- (4) F-100 attacks should be initiated with a high energy level (approximately mach 1) to enable closure to firing range prior to excessive speed loss in attempting to track defending F-86H type aircraft through turns. The ½ r 1! away and down is normally the best disengagement method following such attack.

c. F-104C and F-4C:

(1) Defensive employment of descending hard turns is recommended to defeat AIM-9/B type missile attacks. Mach number of approximately .9 or higher should be maintained.

- (2) Defensive employment of breaks is recommended to defeat gun attacks detected within or sl' htly outside gun fire range.

 Breaks should be continued to a diving separation maneuver if an offensive position is not achieved.
- (3) Use of high G rolls or scissors caneuvers to gain an offensive position is not recommended against F-86H type aircraft.
- (4) F-104 and F-4C attacks should be initiated at a high energy level (1.2 mach or higher) to enable closure prior to excessive loss of airspeed in attempting to track defending F-86 type aircraft through turns. The ½ roll away and down is the best disengagement method following such attack.
- (5) If a gun attack is detected at approximately 4000° or greater range, a 0 to 10 max power dive for separation employing sporadic rolling maneuvers is recommended.

d. F-105D:

- (1) Defensive employment of descending hard turns is recommended to defeat AIM-9/B type missile attacks. F-105 mach should be maintained at .9 or better to conserve maneuvering potential.
- (2) Defensive employment of breaks is recommended to defeat gun attacks detected within or slightly outside of gun fire range.

 Breaks should be continued impediately to a diving spiral separation maneuric if not successful in forcing evershoot.
- (3) Use of high G rolls over or scissors maneuvers to force overshoot and regain the offensive is not recommended against F-86H type aircraft. The use of a high G roll under will result in an

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attacker overshoot 3000-5000 above the defender, but leaves the F-105 with little maneuvering potential.

- (4) F-105 attacks should be initiated with a high energy level (1.2 1.3 mach) to enable closure to firing range prior to excessive speed loss in attempting to track defending F-86 type air-craft through turns. The ½ roll away and down is the best disengagement method following such attack.
- 6. RECOMMENDATIONS: The following actions are recommended:
- a. Tactical fighter aircrews be provided the information in this report on an expeditious basis.
- b. Tactical formations be utilized by TAC fighter flights that emphasize good lookout capability and mutual coverage, due to the necessity, as determined by this evaluation, to detect enemy MIG 15/17 type aircraft attacks at sufficient distance to gain separation and then re-engage at higher mach.
- c. Fighter pilots and commanders should not consider ACT maneuvering obsolete as a result of this evaluation. The conclusions that accelerating separation maneuvers offer the best course of action is valid only against mach limited enemy fighters. Such maneuvers may not be possible if TAC fighters are attacked by MIG-21 or later type Soviet aircraft and a resort to overshoot forcing defensive maneuvers may be necessary.
- d. To increase proficiency in flying widely spread tectical formations, the use during training of "route" formation should be winimized and maximum use be made of tactical formations.

- e. Realistic wing level Air Combat Tactics training programs should be conducted, to include flying clean aircraft, and to include minimum restriction on maneuvering other than flight handbook limitations.
- f. In future procurement of air superiority fighters, consideration should be given to the desirability of high positive energy rate values while under G load (see Annex G). Without this characteristic, speed and altitude loss during high G maneuvering is rapid.

7. DEFICIENCIES:

- a. Rearward lookout capability in F-105 and F-4C was found to be severely restricted. The presence of cockpit mirrors did not alleviate the problem.
- b. AIM-9/B launch parameters of launch aircraft G load and angle off severely restrict the use of this missile in a maneuvering flight.
- c. Specific F-4C deficiencies are as listed in Annex E, F-4C Team Summary.

8. TEST ENVIRONMENT AND PROCEDURES:

a. Test Environment:

- (1) This evaluation was conducted by Tactics Development
 Division and Operations and Training Division, USAF Fighter Weapons
 School, Nellis AFB, Nevada.
- (2) All physical testing was conducted in FAA Special Operating Areas within the Nellis local flying area from flight level 240 to 410, and in the underlying local flying area from 10,000° AGL to flight level 239.

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- (3) Scrties were flown employing the F-86H versus F-100D, F-104C, F-105 and F-4C aircraft.
- (4) All sorties were flown in a clean configuration with full internal fuel.
- (5) Recovery distance was 60-100 NM, with normal initial approach fuel at homeplate, with limited alternate allowance. Missions averaged 40-50 minutes in duration with sufficient fuel for 2 to 4 engagements totaling 20-30 minutes. Optimum recurr cruise and idle power descents were used frequently.
- (6) The experience level of the majority of the 26 participating pilots was high, both in terms of jet and unit equipped aircraft, as indicated in Annex C.

b. Procedures:

- (1) Emphasis was placed on one versus one sorties (one F-86H vs one F-100, one F-86H vs one F-105, etc.), to evaluate all appropriate offensive and defensive maneuvers. An attacker and defender were designated on each flight to provide equal sampling of offensive and defensive maneuvers. Initial engagement conditions were prebriefed to simulate either combat air patrol (.85 .95 mach at 30 35M depending on type aircraft) or low altitude approach to ground target (300 330 KCAS at 20M).
- (2) Two missions of two-versus-two were scheduled for each TAC fighter to evaluate element tactics. TAC fighters were designated attackers on one two-versus-two mission and as defenders on the other.

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- (3) Participants were briefed to obtain data on sustained "G" capability at various mach numbers and at 15M and 35M feet to verify energy maneuverability PsV diagrams.
- (4) Test data cards were compiled during flight and in flight debriefing (see Annex B). The cards were then turned in to a project officer to be used in preparing the final report.
 - (a) Description of Test Data Cards (see Annex B):

<u>1</u> Test Data 1 Card was used on ACT-1 (Air Combat Tactics 1), ACT-2, and ACT-X. On all ACT-1 flights the F-86H was designated the attacker and the TAC fighter was designated the defender. The F-86H was given an initial advantage of speed, altitude and position. As the F-86 closed for a gun attack, the defender countered with a prebriefed defensive maneuver, i.e., break, hard turn, scissors, high "G" barrel roll, etc. Engagements were terminated after desired evaluation of maneuvers was made. ACT-2 was identical to ACT-1 with the exception that the F-86 assumed an initial defensive role and the TAC fighter assumed an offensive role. ACT-X was used to repeat portions of ACT-1 or ACT-2 as deemed necessary for evaluation.

2 Test Data 2 Card (was used on ACT-3 and ACT-4 and ACT-X). This card is basically the same as Test Data 1 Card except both sircraft were equipped (simulated) with AIM-9/Bs in addition to guns. The attacker initially attempted to position for a missile launch, but once the missile attack was nullified a follow-up gun attack was attempted. On ACT-3, the F-86H was the attacker with the TAC fighter defending. The coles were reversed on ACT-4. ACT-X was used to repeat any portions of ACT-3 and ACT-4 deemed necessary for the evaluation.

ACT-X, to collect data on element tactics (2 vs 2). On ACT-5 the F-86H assumed the attacker roles, with the TAC fighters defending. The roles were switches on ACT-6. ACT-X was used to repeat portions of ACT-5 and ACT-6 as deemed necessary for the evaluation. Defensive splits, offensive counters to the split and the ability to lend mutual support were to be evaluated.

(5) Immediately following the evaluation, team readers of the participating visiting teams (F-86H, F-4C and F-104) were asked to record their comments and conclusions for inclusion in this report. Although specific conclusions in some cases differ from those in this report, the team summaries are included in Annex E in an attempt to portray the diversity of thought on the subject of air combat tactics, and counter any possible bias on the part of the project officers.

9. TEST RESULTS AND DISCUSSION:

- a. General: Although there are considerable differences in performance capabilities of the TAC fighters evaluated, they all share the same basic advantages and disadvantages when compared to an F-86H type aircraft. The F-100, F-104, F-105 and F-4C all have an advantage in top speed, all have a sustained G advantage at high mach numbers, and all have a disadvantage in sustained G at low mach numbers. When these facts are known, certain conclusions are obvious.
 - (1) Take advantage of the superior speed of the TAC fighters.
 - (2) Don't slow down and turn with F-86H type aircraft.
 - (3) Employ "hit and run" tactics.

Results of this evaluation strongly support these foregone conclusions. During the evaluation the following results were identified. It must be emphasized that the missions flown during this test were not "hassles" or "rat races". Prebriefed maneuvers were flown and evaluated, even though in some cases these maneuvers were known to be ineffective or foolhardy. In other words, the TAC fighters did not just play their game, but, for the purpose of this evaluation, slowed down and played the F-86's game.

A discussion of each of the TAC fighters versus the F-86H follows. First, defensive situations will be covered, analyzing effective and ineffective defensive courses of action. At the start of each engagement the TAC fighter defender used a relatively low mach number to allow the F-86H to close and although the attack was detected, did not attempt escape until the prebriefed Jefensive maneuver initiation range was reached by the attacker. Second, offensive situations will be discussed, covering not only how, but how not to maneuver on the offensive.

b. F-100 vs F-86H:

- (1) F-100 Defender, F-86H Attacker:
- (a) Maneuvering against a missile attack: A typical defensive engagement began with the F-86H at 5-7 o'clock high and approaching missile range. Assuming the attack was detected prior to launch, a hard turn into the attack placed the attacker outside the missile launch envelope. During this evaluation it was difficult to analyze maneuvering against a missile attack, because of the pilot's inability to judge angle-off, range, and rate of closure. It was

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considered, however, that a three-"G" turn into the attack would nullify the missile attack by placing the attacker outside angle-off launch parameters. As the attacker's range decreased, the 2 "G" launch limit was exceeded. Once the attacker gave up on the missile attack, a follow-up gun attack was initiated.

- (b) Maneuvering against a gun attack: In maneuvering against a gun attack, the defender had two basic options:
- $\underline{1}$ Turn, in an attempt to cause an overshoot and subsequently gain an offensive position.
- Qut run the attacker and move outside gun/missile range.

When the turn option was selected, the F-100 played the turn with respect to the attacker's relative position. Max performance turning was approached only when the attacker closed to gun range. A mistake frequently made was to go to max performance maneuvering too soon, consequently losing airspeed and future maneuvering capability, placing the defender in a more vulnerable position. If max performance is achieved at the proper time (attacker inside gun range), and the attacker presses the attack in the plane of the defender's turn, a very rapid overshoot will occur and the attacker will slide out front. The reason this occurs is that at High "G" loads the F-100 loses airspeed so much faster than the F-36H type aircraft. In a hard turn, the F-100 airspeed can go from 300K to 140K in 90-120° of turn. Naturally the F-86 loses airspeed, also, but not nearly as rapidly.

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If the F-86 employed the high speed yo-yo he effectively countered the F-100's turn and maintained an offensive position. The F-86 pilot. recognizing an imminent overshoot, learned to discontinue the pass and pull up into the vertical plane. The F-86 attack normally had to be discontinued at extreme gun ranges (approximately 3500'). The exact range depended on angle-off and rate of closure. If the F-100 employed the hard turn properly, and forced the F-86 into a high speed yo-yo, the gun attack was only temporarily nullified. The F-86, following the yo-yo, was at six high, approximately co-speed. The turn required to force the yo-yo cost the F-100 most of his maneuvering airspeed. The F-86 was able to slide back down, or perform a roll-off back down to gun position. The F-100's subsequent defe of a turn was completely ineffective because of ics resulting low the res the fight down into the vertical plane, with the attacker at close range, an overshoot was more likely, since the attacker was less likely to employ the yo-yo type maneuver effectively. If an overshoot occurred, and the attacker had very little nose/tail separation, a vertical rolling scissors forced the F-86 into a 12 o'clock position. Reason: The F-100 was capable of achieving a very high angle-of-attack and lost energy (airspeed) faster than the F-86. If, on the overshoot, the F-86 had good nose/tail separation, it did not have to manauver into a vertical rolling scissors. In those cases where the fight was going down and both aircraft had approximately 180K, the F-86 was able to roll wings level and 200m up into the vertical plane. If the F-100 attempted this, he was not able to match the attacker's rotation angle in the vertical plane. Therefore, the F-86 usually reached in the F-100's six o'clock

high position, with the F-100 completely out of maneuvering airspeed. From this advantageous position, the F-86 was able to roll off into a gun position and achieve a gun kill. From this experience with the F-100's comparative turning capability, the obvious conclusion was:

Don't try to turn with an F-86 type aircraft.

A second defensive option was also attempted, other than attempting to nullify missile/gun attack by turning. The second option was to use the F-100 speed advantage to move outside missile/gun range. Ideally all attacks would be detected outside missile/gun range, but for the purpose of this evaluation some attacks were allowed to reach closer ranges prior to detensive maneuvering. This was considered likely to occur at the lower speeds associated with ground attack missions, than at the higher speeds associated with combat air patrol. It was determined that if the F-100 pilot detected the attack outside missile/gun range, he should drop the nose and use AB as necessary to prevent the attacker from closing. The following courses of action were developed as a result of the evaluation: If the attacker is detected inside the missile envelope, the diving, max power separation is not feasible. If a three "G" defensive turn is initiated, the missile attack will be defeated, however, this will enable an F-86 type aircraft to cut off on the inside of turn and close. As his range is reduced, the F-100 must tighten the turn and eventually experience airspeed decay. To maneuver against a missile attack, a turn into the attack is necessary, however, the turn should be just hard enough to place the attacker outside the launch envelope. With only a .3 to .4 mach advantage, the F-100 will take an appreciable smount of time to move outside missile

range, and any unnecessary turning will be to the attacker's advantage. If the attacker is equipped with gun only, an escape should still be attempted, initiated prior to the attacker reaching gun range. If the attacker is detected after reaching a gunfire position, a hard turn or break is advisable to spoil his tracking solution. This turn should be of short duration to prevent loss of airspeed. If the attacker overshoots, a reversal should be made, followed by a straightaway, max power, descending separation maneuver. If the attacker does not overshoot, a reversal, immediately followed by zero "G", frequently throws the attacker out of phase. If successful in placing the attacker cut of phase, the F-100 has a few seconds of safe time in which to unload the wings (0 to 1G) and begin the separation maneuver. The defender should employ sporadic rolling or "S" type maneuvering to spoil a tracking solution until well outside gun range.

(2) F-100 Attacker, F-86H Defender:

- (a) Maneuvering for a missile attack: When the attack was detected prior to launch the F-86 invariably nullified the attack with a defensive turn. In most cases the only chance for a successful launch appeared to be an undetected approach. A barrel-roll attack was effective in reducing angle-off, but if the defender maneuvered properly it was still impossible to reach the launch envelope, and a follow-up gun attack had to be initiated.
- (b) Maneuvering for a gun attack: If the F-86 made a hard turn while the attacker was well outside gun range, a large angle-off resulted as the attacker approached gun range. Under these circumstances an overshoot was usually unavoidable. The resulting scissors

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maneuver then forced the F-100 out front. If the F-100 countered the overshoot with a high speed yo-yo, the F-86 effectively countered by pulling up into vertical plane, followed by a roll-off into the F-100's six o'clock position.

If the F-100 was allowed to reach gun range at a .ow angle-off an overshoot could be avoided, but at the expense of maneuvering airspeed. The F-86, out front, with an airspeed advantage, was able to pull up high into the vertical plane and roll in behind the F-100. The F-100, out of maneuvering airspeed, was an easy "kill".

To preclude the above situations from developing, the F-100 should employ "hit-and-run" tactics. A high mach number should be maintained at all times in a maneuvering fight. The exact minimum mach will vary with the attack conditions (defender's mach, altitude, etc.). A general rule of thumb is: Never slow down below best AB climb speed (92 true mach). If the defender counters properly, the attack will have to be discontinued at extreme gun range, or airspeed will be sacrificed. To break off the attack, reverse down and away from the defender and maneuver for separation.

- (c) Two F-100s vs two F-86s (Element Tactics): Resources allowed only one partially effective mission to be flown and a meaning-ful evaluation could not be made. See Annex B, Card #67.
 - c. F-104C vs F-86H: The following results were identified:
- (1) ACT-1: Thirteen .86 to .96 mach stern quarter gun attacks were completed by Y-86H aircraft against F-104C aircraft. Of these attacks, seven were accomplished with the F-.04 positioned at 35,000° at .85 .9 mach, and six with the F-104 at 325-350 KIAS at 20,000-

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- 21,000°. Eight of these attacks resulted in F-86H gun kill assessment. F-104 hard turns and breeks were unsuccessful and the maneuvers were followed by the F-86H. The F-104 positive G accelerating diving spiral was successful in effecting five escapes; however, if the F-104 pulled up following diving escape, the F-86 could close the distance for a gun tracking position. In no case did the F-104 force an overshoot and regain the offensive.
- (2) ACT-2: During 12 passes by F-104 aircraft against F-86H defenders, gun kills were assessed for the F-104 on six. In all cases the F-86H could force an F-104 overshoot, once it started a hard turn or break; however, on more than half of the passes the defending F-85 pilot had difficulty detecting the F-104 attack although he knew when and from where it was coming. Even when the attack was detected, defenders over estimated F-104 range due to its small size and delayed breaking until too late.
- (3) ACT-3: During 16 F-86H .9 .95 mach missile/gun stern quarter attacks, F-86 gun kills were assessed on 10 attacks. Again, F-104 level turns, breaks the hard pull ups were not effective. The diving spiral escape maneuver, if executed with a rapid roll entry, was effective in enabling F-104 escape. Only three opportunities occurred for possible AIM-9/B launch by F-86 aircraft following F-104 defensive maneuver initiation.
- (4) ACT-4: During 11 F-104C .9 to 1.2 mach stern quarter missile/gun attacks, no gun kills were achieved due to F-86 forcing overshoot in all cases prior to gun range. (Malfunctioning F-104

stick kicker onset at 2G degraded F-104 capability on four passes.)

In one e F-104 gained a missile launch position using a barrel roll attack.

- (5) ACT-5: During three element attacks by F-86H aircraft against a defending F-104 element, none of the attacks resulted in a sandwich by the defenders. The conclusion reached was that diving spiral separation was the better course of action for F-104 aircraft rather than attempt defensive split mutual support.
- (6) ACT-6: During each of two element attacks by F-104 aircraft, gun kills were achieved on one F-86 defender due to loss of visual contact by the defenders with at least one of the attacking F-104s. Offensive fluid separation was effectively employed by the F-104s.
- (7) F-104C Summary: As with the F-105, If a rear hemisphere missile/gun attack by MIG 15/17 type aircraft is observed by defending F-104 aircraft, max acceleration 0-1G diving separation is recommended. If the attack is observed too close for this type of separation, a diving accelerating spiral employing rapid roll rates is effective. The F-104 has an excellent chance to subsequently re-engage undetected visually by the enemy. If the attacking threat is carrying missiles, the accelerating dive, if delayed until missile launch range, must rapidly generate angle-off prior to attempting escape.
- (a) The P-104 has little success in forcing overshoots through the use of breaks, hard turns, high G rolls, or scissors maneuvers.

- (b) In attacking with the F-104, an outstanding advantage is its small frontal silhouette. The F-104 attack should be pressed at supersonic speed, 1.1 1.3 mach, to insure closure before the defender's turn forces an overshoot.
- (c) Both in attacking and defending with the F-104, once supersonic separation has been effected, initiation of climb must be delayed at least 1-2 miles to prevent MIG 15/17 *ype aircraft from cutting off in the vertical plane.
- d. <u>F-105 vs F-86H</u>: During the evaluation the following results were identified when the missions were analyzed. It must be emphasized that instead of merely attempting missile or gun kill, or attempting escape, the participants were deliberately testing the effectiveness of prebriefed maneuvers.
- (1) ACT-1: Ten .92 .97 mach stern quarter gum attacks were completed by F-86H aircraft against F-105D aircraft. Of these, seven were accomplished with the F-105 positioned at 33,000-35,000' at .9 mach simulating typical combat air patrol cruise conditions. Three were accomplished with the F-105 at 20,000-25,000' at 330 KCAS, simulating typical medium altitude bomb mission cruise conditions during approach to the target. Five of these attacks resulted in F-86H gum kill assessment with F-105s attempting hard turns, breaks. High G rolls under and High G rolls over. Three successful escapes by F-105 resulted from separation maneuvers (one accelerating, descending hard turn; one break, followed by an immediate "Split S" AB escape; and one roll under, and accelerating dive). In no case did the F-105 force sufficient overshoot to gain the offensive.

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- pleted by F-105D/Fs against F-86H aircraft. Of these, six were accomplished with the F-86 positioned at 35,000° and .85 mach and four were flown against the F-86 positioned at 20,000° at speeds of 330 KCAS or .85 mach. F-105 attack speeds varied from .98 to 1.25 mach. During these attacks, the F-105 achieved one gun kill, with one probable and one possible. The F-86H was able to effect escape in nine cases and was able on three of these cases to score a kill on the departing F-105. Generally, the F-86 used a hard turn, followed by a break when the F-105 closed to gun range, and forced an overshoot. If the F-105 yo-yoed high, the F-86 was able to reverse and accomplish a roll off with a higher apex into the F-105°s 6 o'clock position.
- (3) ACT-3: Four stern attacks were completed at .9 .95 mach by F-86H aircraft against F-105D aircraft positioned for two attacks at 35,000°, .85 .9 mach and for two attacks at 20,000-22,000°, 330 KCAS. During these attacks, F-105D defensive maneuvering was initiated at typical terminal AIM-9/B launch conditions (i.e., 5000-7000° range, 0-15° angle-off, less than 2G on launch aircraft). The attacking F-86 attempted to obtain a subsequent AIM-9/B missile launch position (less than 20° angle-off, less than 2G, 5000° range) and a follow-up gun kill position. In one case a subsequent missile launch position was obtained during the F-105 diving afterburner (AB) escape, and in three cases gun kills were obtained during F-105 evasive maneuvers (hard turn and diving spiral entries). During two head on ergagements, with the F-86H possessing an airspeed advantage, high and low speed ye ye maneuvering in AB was attempted by the F-105D. In the first case the F-86 scored a

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gun kill, in the second case the F-105 executed a separation maneuver after the F-86 reached a high side position. In the one case where the F-105D escaped from an F-86 stern quarter attack, the maneuvers were a descending hard turn (to deny subsequent missile launch positions), followed by a break when the F-86 closed to gun range, and an immediate entry into an AB accelerating vertical diving spiral with low altitude recovery at .98 mach. In one case after initiating the diving spiral escape maneuver, the F-105 pulled up hard into the F-86 and forced an overshoot, but as the F-105 attempted to reverse into the vertical rolling scissors to gain the offensive, it snap rolled twice at 250-300 KCAS. Recovery was immediate when controls were released.

- (4) ACT-4: Three stern quarter attacks were completed by F-105 aircraft at .98 to 1.3 mach. Two of these resulted in gun kill assessment against the defending F-86H. Three head on attacks were completed by F-105s having initial speed and/or altitude advantage. In no case was a kill position achieved before the attack terminated.
- (5) ACT-5 and 6: One mission combining both ACT-5 (F-105 defenders) and ACT-6 (?-105 attackers) was flown using an element of F-105s versus an element of F-86s. With the F-105s defending and attempting a defensive split, the low defender was "killed" before the high defender could effect a sandwich. When the attackers observed the high defender sliding toward 6 o'clock, they performed a break upward into the high defender, forcing the high defender to roll under and separate. With the F-105s attacking, a low defender kill was accomplished before the high defender could effect a sandwich, however, the trailing attacker was "killed" by the high defender before the attackers could separate.

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- (6) F-105 Summary: With the F-105 in the defending role, if an attack is observed in the rear hemisphere, separation is the best course of action against F-86H type aircraft possessing good subsonic sustained turning capability. If the attack is observed within AIM-9/B type missile range, perform an immediate hard descending turn to acquire a minimum of 30 to 40° angle-off, maintaining or acquiring .9 - .95 mach through use of afterburner, then unload G and separate at supersonic speed. If the attack is detected approaching gun range execute a max performance break followed by an immediate roli in the direction of turn to the inverted position and execute an AB diving spiral escape maneuver. The effort here is to defeat tracking by combining moderate G with roll. As .95 mach is acquired, relax G and level off for separation. Regardless of the speed acquired, the F-105 pilot must not initiate a climb snortly after disengagement, or F-86H type aircraft will cut off and regain a firing position. The above measures assume an aggressively pressed attack by qualified enemy pilots.
- (a) In attempting separation in F-105 aircraft as with the F-100, if the attack is detected at longer ranges (7000'+) the best method is a 0-to-1G push over into a dive with afterburner power, as is the case for the F-104 and F-4C; however, the acceleration is much slower than these latter aircraft (see Annex D), hence, the diving spiral escape may be needed to buy time to effect successful separation.
- (b) With the F-105D in an attack role, attempt an afterburner stern attack at 1.2 to 1.3 mach. If the attack is detected and is countered by a hard turn, attempt tracking down to .95 mach and execute any yo-yos well astern of the defenders. Break off the attack

at .95 mach with a half roll opposite the direction of the defender's turn and accomplish separation. If the attack is pressed below .9 mach, a defender high G roll can compromise F-105 separation.

(c) The above analysis places the F-105 in a poor position in terms of Air Combat Tactics maneuvering capability and confirms the results of TAC Test 63-4 Phase II. This is considered true in view of the high energy loss (speed and altitude) during maneuvering at medium and high altitude, predicted by Energy Maneuverability Theory. The F-105 is in severe trouble if forced to defend in the 250-200 KCAS region, therefore, every effort should be made to avoid this region and to separate and remengage at .95 or higher mach.

e. F-4C vs F-86H:

(1) F-4C defender - F-86H attacker:

(a) Maneuvering against a missile attack: The F-86 was allowed to enter missile range from the stern quarter prior to any defensive maneuver on the part of the F-4C. When missile range was attained, the F-4C countered by executing a 3 "G" turn which in effect negated all missile attacks. Level turns, diving turns and slight climbing turns all proved successful. High "G" breaks and other high "G" raneuvers were also successful against a missile attack, but left the F-4C extremely vulnerable against a follow-on gun attack. The most successful procedure to utilize to defeat a missile attack with a follow-up gun attack was to execute a 3 "G" diving turn into the attacker, apply max power and execute a diving spiral. This maneuver achieved argle-off from the missile as well as adequate lateral payaration to preciude the gun attack.

(b) Maneuvering against a gun attack: All gun attacks were initiated at 3,000-4,000' range from the stern quarter with approximately a .10 mach advantage on the part of the attacker. To defeat a gun attack presented a slightly different problem than encountered with missiles. Maneuvers such as hard turns, breaks, split S, and other attempts to cause the attacker to overshoot were generally unsuccessful against the F-86H. At the speeds and altitudes flown during this evaluation, it was obvious that the F-86H had a decided maneuvering advantage. Two basic principles evolved as outgrowths of ACT-1 and -2.

 $\underline{1}$ It is pointless to attempt to out-turn a MIG 15/17 type aircraft with the F-4C.

 $\underline{2}$ When attacked, the F-4C should immediately strive for separation and re-enter the fight on its own terms.

If an attacker is first observed within gun range and has a .10 mach advantage, it was concluded that regardless of the defensive maneuver, the attacker will continue to close. Any defensive maneuvers where high "G" loads were attempted decreased range considerably and increased the kill potential of the attacker, as his maneuvering capability exceeded that of the F-4 to a great degree.

It was determined that the basic aim of the F-4 was to immediately strive for separation from an attacker by the use of the excess power available. This proved successful against a highly maneuverable but mach-limited type aircraft such as the F-86H.

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achieved by unloading to 0 to 1/4 G and simultaneously advancing to max power. This resulted in a rapid acceleration to co-airspeed during which time the attacker closed an additional 1000-1200'. F-4C acceleration then permitted rapid separation to well outside of effective gun range. While the attacker is in gun range, it is imperative that the defender make the attacker's tracking problem as difficult as possible. This can be accomplished by "jinking" (sporadic rolling and yawing at low G) until out of gun range. It was determined after discussions with the F-86 pilots that it was much more difficult to track the F-4C when viewed from astern than when observed from a position which affords a plan view of the aircraft in a hard turn.

10. MAINTENANCE RESULTS: During the evaluation participating aircraft flew a total of 124 sorties broken down as follows:

Number of A/C	Type A/C	Dates	Sorties
5	F-86H	26 Apr - 7 May 65	63
3	F-100	26 Apr - 30 Apr 65	14
5	F-105D/F	26 Apr - 30 Apr 65	13
3	F-104C	3 May - 7 May 65	18
3	F-4C	3 May - 7 May 65	16

In commission records of the P-104, F-4C and particularly the F-86H aircraft were especially noteworthy. Only two malfunctions contributed to loss of sortic effectiveness

a. F-d6H - One engine shroud binding during shutdown following an ACT sortie, necessitating engine change.

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- b. $\mbox{\ensuremath{\mbox{$\it F$-$104C}}}$ One stick kicker malfunction, reducing maximum G capability on two sorties.
- 11. TRAINING REQUIREMENTS: Recommend the following:
- a. Continued command emphasis on realistic ACT training with a minimum of restrictions imposed above normal flight handbook limits for applicable aircraft.
- b. Dissemination of the results of this report to all TAC, PACAF, and USAFE fighter units.

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ANNEX A

MISSION SUMMARIES

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F-86H versus F-100D

TAC Mission FF-857 ACT Evaluation - Summary

Card #	Mission	<u>Date</u>	Attacker	<u>A/C #</u>	Type	Defender	A./C #	Type	T.O. Time	Fly Time
60	ACT-1	28 Apr	A	113	86	J	099	100	1300	0:45
61	ACT-1	29 Apr	F	294	86	J	099	100	0930	0:45
62	ACT-1	29 Apr	A	113	86	K	130	100	0930	0:45
63	ACT-2	29 Apr	J	099	100	E	738	86	1300	0:45
64	ACT-2	29 Apr	К	130	100	F	294	86	1300	0:40
65	ACT-3	30 Apr	F	294	86	I	099	100	0925	0:45
66	ACT-4	30 Apr	ĸ	110	100	G	255	86	0940	0:45
67	ACT-5,6	30 Apr	F - G	294-255	86	I - K	110-099	100	1400	0:45

NOTE: Letters refer to "attacker" or "defender" pilot who flew the mission. See Annex C.

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F-86H versus F-104C

TAC Mission FF-857 - ACT Evaluation - Summary

Card #	Mission	Date	Attacker	<u> ∧/c #</u>	Туре	Defender	<u>A/C #</u>	Туре	T.O. Time	Fly Time
20	ACT-1	3 May	В	1255	86	R	891	104	0910	0:50
21	ACT-1	[*] 3 May	D	1294	86	s	892	104	0910	0:50
22	ACT-1	3 May	С	5738	86	R	891	104	1200	0:50
23	ACT-2	3 May	r	892	104	В	1255	86	1200	0:50
24	ACT-2	4 May	R	883	104	н	1231	86	1240	0:40
25	ACT-2	4 May	T	891	104	A	2113	86	1240	0:50
26	ACT-3	4 May	A	2113	86	T	891	104	1640	0:50
27	ACT-3	4 May	С	738	86	s	883	104	1640	0:50
28	ACT-3	5 May	A	113	86	s	892	104	1045	0:45
29	ACT-4	5 May	T	883	104	С	738	86	1045	0:45
30	ACT-4	5 Hav	R	892	104	A	113	86	1340	0:40
31	/ CT -4	5 May	s	88 3	104	С	738	86	1345	0:45
32	ACT-3	ó May	B	255	86	ŋ	891	104	1000	0:30
33	ACT-1	6 May	D	231	86	T	892	104	0930	0:40
34	ACT-5	6 May	B - D	255-231	86	R - S	891-892	104	1320	0:50
35	ACT-6	7 May	T - S	883-891	104	C - D	738-113	86	1000	0:45

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F-86H versus F-105D/F

TAC Mission FF-857 ACT Evaluation - Summary

Card #	Mission	Date	Attacker	A/C #	Type	Defender	A/C #	Type	T.O. Time	Fly Time
40	ACT-1	26 Apr	G	225	86H	Q	53 <u>1</u>	105D	1350	0:45
41	ACT-1	26 Apr	E	738	86H	М	530	10 5D	1.350	0:45
42	ACT-1	28 Apr	P	294	86 H	Я	530	105 D	1420	0:50
43	ACT-2	28 Apr	M	531	105 D	н	231	86H	1430	0:50
44	ACT-2	29 Apr	0	525	105 D	G	225	86H	1420	0:45
45	ACT-2	29 Apr	Ħ	338	105 F	н	231	86H	1400	0:40
46	ACT-3	30 Apr	A	113	86н	N	531	105D	0900	0:50
47	ACT-3	30 Apr	E	738	86H	P	525	105D	0900	0:40
48	ACT-4	30 Apr	P	525	105 D	н	231	86H	1200	0:50
49	ACT-4	30 Apr	И	531	105D	E	738	86H	1200	0:45
50	ACT-5,6	30 Apr	M L	338 525	105 F 105 D	A H	113 231.	36н 86н	1500	0:50

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F-86H versus F-4C

TAC MISSION FF-857 ACT Evaluation - Summary

1	Card #	Mission	<u>Date</u>	Attacker	<u>A/C #</u>	Type	Defender	A/C ₽	Туре	T.O. Time	Fly Time
	1	ACT-1	3 May	A	113	86	v	435	4	0830	0:50
	2	ACT-1	3 May	H	231	86	W	512	4	0830	0:45
	3	ACT-1	3 May	A	113	86	z	625	4	1120	0:50
	4	ACT-2	3 May	٧	435	4	н	231	86	1120	0:50
	5	ACT-2	4 May	Y - V	512	4	D	294	86	1200	0:50
	6	ACT-2	4 May	W	435	4	В	255	86	1200	0:50
	7	ACT-3	4 Kay	В	255	86	х	625	4	1600	0:50
	8	ACT-3	4 Nay	D	231	86	y - v	512	4	1690	0:50
	9	ACT-3	4 May	В	255	86	W	625	4	1005	0:50
	10	ACT-4	5 May	V	435	4	н	231	86	1005	0:50
	11	ACT-4	5 May	V	225	6 ,	В	512	86	1305	0:50
	12	ACT-4	5 May	W	625	4	D	231	36	1310	0:50
	13	ACT-3	6 May	С	238	86	W	512	4	1005	0:50
	1.4	ACT-1	6 May	A	113	86	z	435	4	1010	0:45
	15*	ACT-5	7 May	B - AA	255-231	86	v - x	512-435	4		
	16*	ACT-6	7 May	v - x	512-435	4	B - AA	255-231	86	0920	0:50

^{*} NOTE: #15 and #16 flown on same mission.

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ANNEX B

TEST DATA CARDS

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Speed 'although	1	-	1	Barger, peut morne allacteur achieved quinkill.
Schoours, 8 Reserbate	1	1	1	Ellackees Lorganist it it 5550 privacy F-4 of the hord
Hist G Ball Char				lett fevel trypo I had no proper tracking to
Recovery Speed/hithtude				FUCCH. Could not close to less than they what
Mid of the contract of the con			ကို	down of low speed youthe and of Met soun necessary
Actovery Speed/mitteds		ļ	Moclan	1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
tecaps selitared?	Ale Ale	N	λ,	The second affects from 4 october but to Close Jaskerand
				क्षितं है जिस है है कि प्रकार ने ने के की कि है हैं।
				1 the same as the is except that Firt did diving

7	forel has 6 4/6			Roll off - Jord Superentien,	20m 5000 - 1200 - 40-30	A AT ARMOSTER	Sur kill.	Jole Gum Kill	1230 A. S.	tacked to 1800' - Malo up	Sido Pour	List Lite Paris Const	1 1	ost to much	overshoot, which caused	after mershoot	er is the last	न्युस
· ′	Metrude Mach		Describe key factors for each sugarment.	-730-150	व्य पत्र	1 /1	- parpara-	1/2 40. Sterri trac	7	The Salve	'51 <u> </u>	The sales of the sales	in the s	9.	Causand paresho	at cooke	4 to fellow attacker	9 "
CONFIDENTIAL	3. E.M. Durie Post. Lands Ale		Office S	L. Teachrad 4	The Kill	2000	Theorem	11	not the State of the same	1 2 -	Kent C	" Come and Come	य मार्थकार्यक्रिया	<u>eg</u> .	ฝ	अस्य में कर्ण के	7 1	1 1
+ CONFE	INTERNAL - Des naturales 657 - APP L.D.S. (Fill in blends) eross ont lasppillable entries)	AC 0 hate TO Time Ply Time	a sumirity	भार हिमस् है भारत है। स्पाद	भट्या कहारा कहारा कारा	51135 ASBSh. 122 Az 1220 No No No No	No No No No	Ches Ches Che Che	5.75 20.75 20 75 20	10 10 10 10 10 10 10 10 10 10 10 10 10 1	02 226 62 025 04 022 28 225	530 135 53	1 No No	No No No No No	_		1No 1 No 1 No 1 No 1	20° 20° 20° 20° 20° 20° 20° 20° 20° 20°
e . - '	AMELIANA - Tac mission as? - (Fill in bimbs; cross out lampping	Accessed F-40.		type Attack	Infilel Speed'Althrude	Torninol (33CO'L, Speed/Altitude Migh Speed Towfo	asli Gig	Cur Speed Yu-Ya	2. Ericite (Inicial Speed'n. tinde,	Mena.	97-31117,70065	Markette, 7 24 scholls	Arcovery Speed'Aliliace	Man G Mall anier	factorety Speed/mitteude	Encape Achieved?	כיי מווו:	Hare Juen

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. At tacker	Misc	16 970 F-40	• 34	•	# #	rly ties				
Beforder		E-861	10007072				BOTES: Describe key focul	107152 Describs key factors for each engagenent.		
1. Assesser	Ħ			-	4		#1- Armet	HI loss of usual andort Prince	action of	المالد
-662	Type Attack		3 2 5	+	+		Ciceoraphach	accomplished with time for	1 4	NUK ORK
Toral .	faithe boosfaltires Terainel (1360's) Speed/altitude	6/aleteuce	07/E3/		+			().		
H THE	Migh Spued Yo-Ye		20				The Const	9-		83) Deno (58)
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	d. <u>Existing</u> (infile) Speed m. ! des	, p 66,	2783	-	-		7 0	O		
ŧ	practice that Share		12:5							
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(Mil is biants arese out tappiterble secrios)	irees out Leappli	table estries	•		The Annais Alstruds Mach Lucil Man G	3 4″
Hier 4/6 type	4/C # Date		W Hee	aly thes		,
198"L						
3	Bragwood 0				BOTES: Describe key factors for each engagement.	
3. Assessed	1.	3	j			DM attack
Lype Access:	ड्रीट्राज्य ड्रीह	sligat speat	19.7	; ; ;	1	· beoke at
Interest Speed falt tude	डिड रहा है।	SE 136 04/18 SE 138 05/130	89/40	86.138	scoo con above, a limited amount of dun	of duns
Terrinel (3200'%) Speed/alettude	145 25 36	25-126 11 132 197	125	मह ।	×	Kazago al
High tocod You're	200	2	3	3 3	o at this time an a	المال المال
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Lar Speed Ta-Yo		- C	7	7	the same of was compossible to tack atomy	vacto star
21:13		7	-29	\\	نيلا	المحاوية اعذ
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Speed with the sea	4	ट्टाट्ट ऋष्ट	Ľ	ज्ञ ध	Polis Ors. Erro for a missil alleri	STORES OF
Sciences o severable	作业	4	1	4.		
Actority Residializate	1 2 1		31	र्वा	41	San Coop
nigh 6 hots ander	A.2. A.3.	, 0,6,	3	No	Expectation agents and bight dividentes	Leales.)
Laturety Speed/altitude		91/2			>	-
Cotago debitand?	Yes 10	Ц	2,	2,	Note: F. 36 could chain a missile kill eveny	- Kill girton
Gen still?	46 44	47	97	Nο	The after on entarshort by the Fit.	-4. E3h
					Louis possibly obtain a dun kill is For	185

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Altituda L S.K. Terre Parl Leads (Rill in binabe; ences one tampi

Level/Max G

75/20 82/2C .8132 1.831 261 7/17 Ş 7 ny the 8/24.85/26/86/36 S5 40 .8/39 51/16/19/1/25 Perminal: Officially) Speed/Angla OCE F-86# 四日 Pefenden - Inicial Spendaletenia Mostle Elli: Lange & Angle Gil Terminal: Om Attack (3000'E) Mortie Attech Delpted Pertical Bolling Scineers laited theselibertude Literian Over Seac. berrel bell Accock Eigh open forte beaps antitoned Land Terra/Desait Low Speed Yearle Marie Spiral type Accord E 1117 10 11 of -L ALTERIA AL ALE

intered board discending free when Racide. To tial missile & gun escape achieved by to translate divina novell de clindbing same Civestion of successful missile attack: Could affacter discriminate IR to be against a ground maken. allocked or 3-3/2 will Phaker closed by cuttors # 2 Defender back diving there when others Levels it less William 216, For south and within a chieve a missile affecte - this hoo asitioning (magiganaki) TE delender trice Defendent did not atkingt of diving bloccleration " word," Mois, 'G' - mapthy stemper dive used turn + her G' increased excellent cut of missile or gun parage ore atlacken cout 'cut' actas circle temas quis Kings. 4.3 D. Jadir - 3pil. S' athelier & with والماعلان علامين In whose Attacks defenderwas innoble. to Hy belone helicen 2-3 mile se divertions to principally. Knusid by the delay in del acies cink -- prosible missible - Ni Gun as seince speckised to soon! to saids nosc, affector exis 4445 -1-2 allenks be. E.C. forth: Describe kny factors for each engagement. 12 35-32 Linitial Enclose attacker cilluckae Ceuld #1-Diraha

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Rise AC Type	• 24	3 4	tien tien	fly thee	
Total Control Control					
Į s	Park ment				NOTES: Describe key factors for each angagement.
1. Attende		2	4	-	Uthen Livis Commontation
Type Actock	W/S	11/17	11/1/		2 stran attack in trate 1 st 35111 - 24 tacker in blind year Excens
Inleis Spood/Aletendo	84/40	91/30	16/25		MErrewich Secretagished by mar pur chiving (3 to 6) to ca to 13 c
Tarminal (Officials) Speed/Angle Off		1	7		14 Mac 4. G- lord molecate but not enough to occount souther
Sarrel Boll Accack	16.	N.	14		Httaker was observed 25 to 36 6 055 min range 4500 ft. in
Missile Kill? Longe G Angle Off	J.	200	200		Hist think of mane sour 1stornathink in blind is oblock area
Terminal: Our Artest (3000'E;	1	,	3Mh	<u> </u>	24 sein-max gree hard trings-c) for about too at 194 Hora
Migh Speed De-To	No	677	110		ness law (2.5 6) 26 colorstan to 13 Mach in continued turn
Bell Off	J.	110	13		two was started 7-8 m th cange attacker was not absence at all.
Car Speed To-to	11	3/	20		HHz. Key's Chrum Ator
Gus 12117	No	No	fes		#1- HH3 N starter at 4011/ with leterises at 3511- astable to
2. Lifthist - taited speed/airtruda	56/20	12/2	22.20		reach high enough mach to chose ningerly and ended in a tail
Lord Deribanair	7,65	16.5	1,45		chare between 24-1000 levelak betender trank ant wash of organit
Manile Atlanta Pafested	×	765	165		a shot in the 30° cane with less than 40's. Wetender rolled
Marine Spiral	ŽŽ	16.5	165		These griss to closing in the gire things.
Voteleal Milling Seinover	17	N	77		# 2- Hisal started at 38 11 with detender at 35 111 Lines of
Attacker Over Shoots Speed/Altitude	10/1	16	14		TOSE ISON ANSA CHICARIL a missile shat with levethen a.C.
License Achieved?	16.5	Kes	duk		ting the training shat at mak gon range
64 E1117	11/1	11/2	ZINIZ		3-HHal started at 2501 with detended at som.
					Wickening C nover 12 was when I was in miss: I'm
					रिनेत्र्यः वर श्रुप्त रिनेत्रहरः

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> 25/29 85/25/28 95/28 95/35/35/35/35/35/35/35 16/10/19/15 \$ 2/5/10 30/10 785 10° 1483 10° 1985 10° 5,45 128 /2/1 Immineli(Missile) Speed/Angle Off. 2. Befonder - Initial Spendialestude 5-40 th sile Edil! Lange & Angle Off. Terminal: Gas Actual (3000'2) Intifal Spend/altitude Lerrol Boll Actuals Lith Speed Ye-Ye Lav Speed To-Ye Note Surs/Buck Dr. Accael Out #1117 130 Tlet 1. Attecter Krewner Les Defeater __

1/4 Fer labe to close to gave conge. Rave lock could flee Abby to track Europe 5.15. In 1806 thurn, F-86 No insessile kill because of F-14-36 thurn but F-86 could thack could that missile earning. # 5 - Same as 4 track oble to Frack Give Range for 210 thurn the could be in the frack Give Range for 210 thurn the could be in the interpretation of the could be in the interpretation of the could be in the interpretation of the could be interpretation of the could b of two down My sped was i 94 - 1. D. Atter about lot of Munn Gi missile attacte stach coon-Chadanism to Aldero Hanselal in a solit S + my 'S' intolaged to Hast + Over Mach hi His Similar was initiated when aftertree uns approx. Good Attob meet at 17,000, then lesoningled Attacker miss have whingto was within 50-10 of west-askern. Attechour neuron accelemted in 1,25 M. - then fer mindiged. Hard tern Devolers Comments: #1-12 Kinden in Hated hard descending application - lowered Dose more. Allcelon in Halle @ Sonc. This seemed to be best escape homoissile affect 3-5 '9' Terminated with a Hailer chaiming Offerbase Comments # 1. Storted missil atticle lord outlings 1.4 Mis. # 4 - Low Olt descending bighorde (1.3 locco ~5-10 2 cff. Drkween nambaining 3-56, Brok ated to 1.4 M. in a descending Rolling spical. Betomos I wing 3 G or more continued diving 3.5 6 soing #3- Essentially same in #1, hut levatorited @ 15000in free set to our TS + F-4 went outof right conce #23 - Startel 112 K' closed to throw easy tracking at 1.5-3'6'ler la closer. Han 4000' 442'- Defenden reduced exte of 15 POTES: Describe key factors for each engagement. (ज्याना अ

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Attrakes Over Mosets Speed/alstacks

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Vertical Bolling Selsonra

Mwieg Spirel

Etablis At tack Defeated

lassmach antargati Streep dus na restitacks at hich mach were com debate unsurcessful due to difficulty indius recovery we will be extremely see that a excape maneuver.

(Mill in blombs; evens one tamp; identia marries)	CRIL to Markey orms and form	silestis e	itemite merrien)			Not Reside Alectude 4/6
Attender Act Tree	100	i	12 th		Ay thee	
Marie ESLE				!! !		
Masser Lea	PROTEST O	ŀ	}	F		Defendent of Comments:
J. Accepter						#1-Astec break and observing overshort did not have any
appo attest. Kaletal Brand/Aleterda			1600			appartuaity to get into give of missile posit.
Tormineli (Massile) Secol/Apple 052	6.1			30	10	*2- Same 35 *1. however as attacker came portos yaya was
Berrel Bell Attack		1	1	12	2	able to coverce solf fell into six o'clock about 3000. 4000
Mostle Will Lange 6 Angle Gff	Ser. 36 165 26		30 25 3c 3c	30-35	110-45 15-45	
Tarminal: Om Arrack (3300'2)	1	1	_לוווע	_	1	#3-Nevac did nove ettocker in sight until he colled
Migh Speed To-To	Yes	Xes. V	-	Ves 🔝	ره	1500 set and to Virgilities 235 other deserting initial missile
Leli off	7	13	و		9	A - Share As #
Lev Speed Ye-To		र वि	q	7	E)0	5- Httscker trees to June 3the initial mouth of Livith me Has
Ges Kill?			Nes	P	Q Q	note which at the man him hywares carle wat climb of ever
1. Palinder - taicial Speed/alcitude	91 15 81	5	C OEST	नियट घट	75 20	maintain alisque ed while other option to apin addantene
Mard Turn/Break	7 2 2 2 2	7 227	3	راد	. j	HITHEKER'S COMMISSIONS
Mostio Actual Befores Gift.	3	٦	Yes	Yes D	6.5	GAKE FILLE 1835 de fe sted en all passes. Recegnation ark position
Elving Spiral	2		-	No	V.	Lackgricon Refacks were excellent top softeen till Sharlder
Vertical Bolifag Scissors	1	1	7		را	BACKESS INCHES Tressently Close & loss of wisued Sighting.
Accordan Over Shoots Speed/Altitude	। श्राटहाङ्ज	<u> </u>	28 7	17	13स	* Jastruge of hoest should be removed to better recentision.
Decays debieved?	1	2	7		5	Emph213 1245 places an ice similar missile enuclape using
** #III	42	1	O O		2	11 1. 1 00 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
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						1990 The Little Mittate of Closure, 16 speed on the 12 length 100 10

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3. E.M. Turns. Prol Senate

THE MALL - THE MESTICE 657 - ACT J. C. R. (FILL to deman) errors are imagelicable aperian.

Ay the 10 Tam Srew Sreed. OSM10 11.11 10. 1439'556 2 12.5 Jus 165 . 85/20 Yes ž 2 2,2 ZZ ZZ 170 2/20 Attacher from Shouts Speed/Altitude Terminal: (Motile) Speed/angle Off 1-26H 4.4 Definition - Initial Speed/altitude Mc type Missils Kill? Reage G Angle Off Terminal: Gen Arteck (3000'M) Massia Attack Defeated Vortical Boiling Sciences Initial Speed/altitude Lecret bell Accack Mgk Speed To-To Incape Achdered? Sord Para/Bresie Low Speed Year's Merion Spiral Trys Attack Attender Defender כש מוווז 11121 Bell off 1. Acrester AMERICAL TOR

assibiste away-gen test. Ist kard tran for 30 noch turn peur-S- willing to to look up to 296 - 34 no much or gun till good attackers Convinte : # 2 Sedwinder leil : fellowed by gon attack . bli hi 34 - 386 minuted #4 Erred and attitle other defender broke - still ast asso to press ted or track - rearehet be too in torsel us at re goon on midell till sour and bi G to among aut-HE: Yermisile fill - fren attack with tracking down to 2300' - oursehort devise tre being to 1200-1410' co over 6 increased to 55 65 not by aink attack but it court actions are attack to the north our Calib track important # 4 - 426 tribe best lift mulling high of George 14 mouth and am attack, #5 386 Level him rede land two - 34 tracking - 316 hugh Griel worden - 34 look #5. tertial dix - Backed to 1600 at high to butte aff - gum bill rate of chains by 34; #2. 3860 & broke herd and during presting two dura . Wi G up to . Th' and caused 34 resolut missifu # 3 Me round hill med tracker to 1500 - Cur Lett - ways up about . 16 - escient remail after but 14 actions gan attack tracked to 1600' as depute amount to soon-am fish except. #9- 386 rolled our laits but 34 achine attacher. white early best 34 coursed warrenessy over MOTES: Describe her fectors for each engagement. #6: Alduder Solits - no pulled A. #1: Ating Solit S- wich mound and noilest aux bire

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4 3
missi cress one trapplicable
OTIL SE N

Defender	196H				•		
3	Magazi les	Pressent 4					
4	25Cacker		2.	3.	6.	5.	•
•	Type Attack	4.1.1	7.3.11	4. E. 11. C. 1 Sam 11:5.4		Stim	•
-	Infedel Speed/Alexande	1478 16	. 91 32M	.37 ZZM	NE 2 55.	1776 68	•
•	Terminal: (Missile) Speed/Angle Off	101,	1.201	35.4 1.6 M	26.4	7.0/7	•
-	Berrel Boll Access	27.7	Ne	1/2	Yes	11/2	,
**	Missile Kill? Lange G Angle Off	XG.	No	No	No	11%	'
_	Terminal: Gam Actack (3000'2)	11011	1.1.01	1.10	No	111.	
•	High Speed to-To	Yes	N:	1/55	1.0	2/2/	•
**	2011 Off	11.13	Yes	NE	/es	2,2	•
-	tou speed to-to		2,0	λ,	1/0	ż	•
•	Gue K1117	765	1/55	163	.10	1/65	•
**	Palander - Interest Spend/Alternate	25/35	. 2/35	.2/25	75/22	.85/20	•
	Ward Turn/Seesi.	Yes	Xes Xes	×55	Yes	Yes	•
	Massile Access Infeated	4	XSX	753	Yes	Yes	•
	Clutch Spirel	11:	1/0	100	11%	Yes	•
••	Territor Tolling Schapers	12.	Ŋ.	100	No	No	•
•	Attacker Over Sheets Speed/alctrude	0,0	165	Yes	Yes	Yes	•
~	Becape Achieves?	No	Ne	110	Ϋ́εs	Yes	٠
•	Com 52137	ž	No	110	100	No	'

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Level/Max 6											
Ŗ		ick engagement.									
Altinda		key factors for e									
Not leads		NOTES: Describe key factors for each engagement.									

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THE BATOLE - THE MESSION 837 - ACT 2. (C.) X. (C.) (C.) ACT OF AC

West in promise store out theppitchela opition)		Tario de la companya	is secritors)		Puel Remain Altitude Math Level/Man G 4/6
nise Mc 7790	*/C +	B ts	or the	Fly Time	
3.86					
Inure la	Interest (NOTES: Describe key factors for each engagement.
I. decasker		,	3. 6.	5.	Alderto a Commento :
Type Attec.	111/2-9	11193	1. 5-6/41		Al Whattada at South Satisted wife diventive withingwing to count energhal
Initial Speed/Alcicude	.3/40	.9/38	.3/24		and then solled barlows betattathe a good was raintained and engoed come by buding
Terminal: (Massile) Speed/Amgle Off	11 12/10°	17	1500 11/200		ordinary.
Barrel Roll Actack	270	12°	100		The Milbertiller at 2 miles this time a based luna count overstorietie, but when welled on
Missile Kill? Lange 6 Augle Off	770	120	100		Allano with lest the desighown and collect climbing - I was broite but will not there.
Terminal: Gum Artack (3000'R)	ζ	720	100		to giro hard
Bigh Speed To-To	700	700	220		Bille attiller of Benefer Dond twend by Jana Colly but to the right of the ctacker
Reil Off	2	22	20		weathat Other think to at lack with fill will radd nall half was above and
to. Speed 10-10	Ż	72	70		dured tim a lorged trading a History change to and a good and fill
Cus Kill?	2	γ_{lo}	20		#1012 attack Secretify of dependence deciration of attack soull trait
2. Defender - Intrint Speed/altitude	350-7	06 7+ 05E	450 56		at list tran 2 Sints agained Indistant of trick up were proudly I rolled out
Hard Turn/Break	46.7	12/62	Usa		And germed to 45m West ministe attack or as sout believed were earlied
Missile Attack Defeated	20	450	452		# 2. W. Lande defenter without dering the airteation of forther thing on a almost
Diving Spirel	Z	470	10/2		imarbuth 3 to the head with be and their stal at 13 th 30 me - sometim with the
Vertical Bolitug Sciesors	Z	72	Zieal		right admission it is difficult fortingmist to assume the attach visiting bourses.
Attacker Over Shoot: Speed/Altitude	MADELL	~ ~	12900 14/220		the rada who I the world ground granged yelling and in hot we made and both wains
Escapa Achiloved?	7767	2160	140		rador walt no vernally exprised tot at Knillo, 12 iloco
Gun #2117	2	20	18601		#30 En attoch - 112 plaint delinters game and tried tometra now
		1	1		10 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

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B	le vi	(Pill in binding some one in		plicable meries)			1- E.M. Turne. Past hemein Altitude Mach Level/Man G a/C	
Nice A	E-9(H		i	8	2	ny time		
States at a state of	37-3							•,
Bearrer Los		Laterance .	3 5				NOTES: Describe key factors for each engagement.	
ACCECTOR			1	_i	4	-		
Type Actack		当	当	事			H Coscadin	
lateral Speed/Alerense			22,32	3	20/33	T A	5000 \$ 1030 0000 000 1. 4. 4. 4 (18) Hitch Hotel Care & to	•
Terminal (Missils) Speed/Augle Off Retrai Ball Assash	/mgle QE	3/4	3/6				cornel capialy.	•
Missila Will Longs & sugle Off	770 of B	1	10	19	1/0		#2. Debenier in thated 22-36 HB descending torn when	
Territori: Com Actock (3000'E)	2	10		100	25.50		3422 Ker 3+ 5000, 'C' = Mu bo: 1+ +0 4 : 12 3 Har Ver chine to	
Kigh Speed 70-To		1/2		10/0	10		4 too 30 2 off 3 G. then defender Keeping 'C' on 12 jily	
3011 012		1	11/2	14	115		Severated Terminal altitule (111).	
Lev Speed To-To		10	10	115	11/2		- 3-D-sender whisted stylls hescending torn seclesities	
\$1112 and		1	1/2	11/2	1605	V	to 135 MW = 412. When the court spores below all the	
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Torniani (Missila) Speed/dagle 368	Ц		महर्मः नेया	Ver spir powered with the	14. made Successful escape with	علىت
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6- B.W.	No Ves		tog words	क्ट्रिक्ट 17 राज्ये	Rate and 12 make left han to down of A112	518
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का - रसमामा	111 142 2 - 110 million 117 - 157 2 (1/4)	3. Life lients
on jained at LIM)	(Fill in blocks; arose our lampilisable merica)	Paul Lenain Aititude Methods Laval/New 6 A/C
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1 175		MOTES: Describe kay factors for each engagement.
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1. Attactors	1. 2. 3. 6. 5.	C. offer the 183 willow off high Regarder #162
type access	G/4.c G/H;	2. K. 10 d. Dec 20 hat Could at the world Colored
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NTIAL	Lin 2004 Militado Mach Lavel 1806 Nach Colon Sales C	30 183 4.5	25 X 5.5 F. 86	Friot unable to cause rivershoot on any	TRIED LEVEL Clin	Co last	क्टाकेश , वर	divise Spiral CYK Dulka (p. 172-17 de la		F-104 unsuccess full in climbing Soien													
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()	LEMINO.	71100 AC 1974	Mineral Formics	HARBITAL LCA	3. ASSess. 2	Type orthody	initial Speed Altitude	formand (3508's) speedaltitudes	Rell off	24.00	2:: 48	2. Betarrag (Initial Spoof'nittades	Bresi	Attacked Over Short	Speed 'altitude	Seisveffs, & Leverbais	TIGN C BALL OPEN	Lacovary Spand/Aliterate	Man o wil wear	intrody Speedhittende	Fe' 47 + Achieved?	Gen 12322	

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161	<u>131 bill</u> - 'te assiss 85' - act <mark>b). L</mark> (Nil is dictas eras suc implicants merias)	AC 32555CM	857 - 4C dapp1/cco1			3. E.M.D.
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1. ALLECTE				4	13:	204
type Attack		五十	144:	144		2
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2- E.M. Turne Post-Sameia Abrirudo Hacch beredings (j. 1 Altackens Comments, 41 Phacker started by

end est. Chershot and high to tid me to chimber in DR Hean Relled once tothe sight. I'm trien to follow him daim of the Dressouted to problems.

Presidents Communition of the ps. Unable to # 1 level break for of land flags. Unable to acceleration. Unable to get autreport.

3 Break that Climbing high G, Nb president - The Rolled over the Eleventable to be a feether.

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INI MAN - Dicussion 657 - act (3. H (Wil in Dianus arms our languiscubs marries)	C MISSION	in 1837 - Lange Library	- act(), 3, 2, 4, deable merten	 ?		2. E.M. Derna. Pres Benefit Alettude Moch Level/Man & 6/6
Nies Me tre AC	FVC •	ž	, p	8 12 13	and the	
Henryer Lex	Equipment .	• 31				MORES: Describe kay factors for each engagement.
b. Attacher		•	ř	٠	5.	41. F. 104 that thend nearly level where File colled at
Zypo Actack	3/1/1	11/1/2	14/6	iffic		All lange- no overshat Fil ible toclose ing en
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tar Speed Te-Ya	1/2	16	1/0	11/6		to 12 Mise shove hallson Fill mile stokle Minge 3 no tooking
543 K6117	22	72	110	110		wat / Etoystating to open up lange.
2. Extending Unicial Spand willings.	-3/8	18/25	28/8	.2/20		4. F. Plat AM Game 12 Mach Som Frey to lit ket descending
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Attacted over Shoot	160	30	110	1/2		to 3000 it who had mark we will know be a down incredic to the
Speet'alticuta	1		1	١		مناسف كعصور عدول معاليه عدوم بالتلايات عد آس للعالية الاتارة وعرموعة
Scientis, d Americals	4	14.	17	160		करमायक कर विकास कर विश्वास्त
High G Ball (Voc	160	16	97	110		אפן - נופה שפוני אב לסיא עדיומי ודאווונים וניחב אם ויחו-ץ - את
Amenical Speed/Airlines	ı	1	1	1		beek store sharp shally and begin squist-squiling tile testing
Righ G bell ander	110	11/2	11/2	100		الله عاطور الواد الماحية المرك الماعدة المام الم
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Botape achieved?	4	3	1/4	Ves		Long Segments Deed Deed Telemosted Tot when on the telemosted Total Segments of Segments o
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1. pitting	.,	20	3.			Asutolal tilly Lin	3.104 Kenny	Assettled tilly be 3:04 hearen A rout A
Type A:Test	3/41	(Kere)	Guerel			7-104 Delegan	The state of	A-109 Medicine and the line of the
Intital Space/Altitude	9/40	7/56	25/36			to see freezers	1 making soll	to de fell to tive of milities and Pour with the land
lerning: (13.0°2) Sprod/aliticuda	14/55 1.2/50		11/22			pilat row Ortest me	The current of the state	Bill trees letter hand were aftern much contract
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Asli off	11:15	21.12				with me to and him	Lecour then mak	within it and be sheenen then making ground, bill time
Lan Spane Ye-ta	77.5	27.				Burged There wast	is needed resition	reversel There were to neight resitioning fresh to met it
4:: T WO	X.	13.4	1100			trick letter range emtact.	1. emtact.	
8. Lefacia (Inicial Speed'a.:::.deg	.85/55	\$5/33	155/20			attactus Comment.		5
- Here Sum	2/4	21.40				Hete. the delimiter	was wordle to	Hete. the delineter was weather to keep the or trake in
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Migh & doi: ander	7%	26	7.					
dots any Speed/altitude	1	1	١					
Secupe Actionses?	24.00	Can	2/2					
6mm 84117	177	20	*				•	
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THE PROPERTY OF PERSONS ASSESSED.

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LATANAL - 126 ABSSTON 557 - ACT L. D. I.

Z 200 125/24 1/2 346 81/15 9/30 12/35 . 1 1-10KC J-86.H i. Infection (taleial Speak'n.:::..des Termina: (3Xt '2) Speed/altitude 4/C 2/4 bestreety typed'hittende mis Hack Lums Salmannamb Lasarsald Attacher Ever Most Speed outlende Intital Speed' attends Righ G ball inder TAP C BOLL UNAC Kigh Speed To-To Lav Speec Ve-13 Mice Dye Attack Sus 64.1.7 Rall Cff I. Allera Defender __ Laurer Les Accesses ...

L'aum over het Sill wellet gain advon # 2 Could not we nother the bour called break, mused more at 3000'R alle to track In 3 seconds then overshet. Birke down Wit still outless & acide O believes + hat #2. Closed at willy called deputate triate at 1 miles all theat. I tel Silvates Lord turn at sandt haven. 104 attack sond 12 when actually by our 2000- 3000 let Gound overshoot dill wining land two best was weally to close truning broke South town amiled about all but are of 3.19. Mount attacken was out of longe #5-Allen bile I coexibet so south up to 38000 and elegand. #4-Flk perferand bard two at 4000° Weall. to trook while in dillicet to redge destance tone with theirs to tollaw light spail you atacker agained to be tracking with ICTS: Beseribe toy factors for sach enjagement. that but could not rain advantage into diving stiered and wared Copiesed to suday 5 104 Strage attaches Congrunts: Setender's Comments. to lede than 4000 Let. #4 Weblerd from #3 Wick fort tom. P. LIA. TUTA

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for sell?

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TANK THE PROPERTY.

3. E.R. Perre

CRill to blembe, evers out happileable merries) ELECT - Demine 81 - ATLOS

#13×c 4/	A/C 1790	*	Pette	#		Ny.Tles	
Atteches	3-104C						
Parlanter	7.56#						MCTS: Proce
LEGITE LES		September 1	•			,	Asterduris
l. Allera		ن	į	1.		1	#1. Starte
type accord		5/41	1/1/2	1 141 4/HI : 71 0	71.0	shu	שאוקרטהו
Intital Speed'altitude		.82/55	82/55 . 62/55	6/25 1.7/30	.7/50	185/50	#2. Garas
Serakasi (3%3'4) Speed/alcteude	letende	11/30	05/0.	11/30 19/50 1.3/52 1.0/10 1.45/20	20100	12/56	to his beiles
High Speed Years		72.	11.	27.50	21001	214.0	# & OWater
1311 GTE		7.	11.		2	۰	new hireway
Liv Speec Tarle		Me	10.	27.	7/3	2/100	Elen wiel
Sea 42.17		Air	1/10	2%	11/2	21.00	12. 20.10
2. Lafaileis (Inlessat byond'niversates)		12/5	2/21	72/c 72/s 22/se	02/6.	2/25	#4: 3 4:4
son that term		214.	142	20.00		24.0	and best no
Acces over Stars		7.24			211.2	27.7	#5 1640.00
spect, vistande		12/2C			د_ا	17:120	Lest icht at
Schoots, & Barersals		16.0	74.00	24.0	71000	25	attaini
Mar G Roll Cree		744.	316	710	ž	ż	weektow
hattvery Speet/Littleda	J	. 2/3,	1	•	i	,	#2: 120
Kigh & hall ander		160	10	16	15	20	guild net o
despery Speetlalitists	ŧ			١	!		Two Ather
Factor debiterally	,	18	240	140	The New	26.0	#5. stellerde
			`				•

it at it is the noon tants. I get how also - 40th B 1200 select the trothie ceiled but he receiled separated in a shallow low and lift two causing marchaet in a new rack links I howard cher town have been withwell with which level de acutersattech acceptated away #44: Ne AB well will rays Asperter #5: Niè square corner - Te yo-yest witch a 'zest-ower, "86 biet me and em-trouch twom, attacker @ 2 miles. Net dipoder even attacker at-this rectich aur songe thee did herholieng time and say over the timb leavet I had be derivering time rowing 100 to received. I recovered de rated under any we with it is isoland in the vestical and bough 108 went orly un ading and degeneting or action Beten get Commenter Al. Brokelo das but lis it week lite was then went to be strand into all the them longer but ford it two who red wis chiefui 3500 range. He reusalist and to twand lasty and attento en last with the exceeded decon and away and initial as Mack. People in a nathing diversand started der revered water - was about to guess across for an intlinte. " Why wast high the rasheting rust att dinting two t at about seconous but be unleded and deparated Lavel Mas 6 CONTINENTAL it would have resulted in a head on pass. Ever en web duringing low 67 wines id the ruled ans high to my be gibe key factors for each augagement. Arch Im a dun till Althrade · Comments: Pari- Leads

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Athe Mc 270	* 24	i	TO These	_	ny time	
Manuel for	Laurence .	•				
1. director		7.	3,	ė	5.	• '
Type Accock.	3/1/2:	3/1/1	5///:	1111/1	7/11:	
Initial Speed/Altitude	3/1/6	2/29	35/20	3.75	1.85/55	
Terminal: (Missila) .pood/Angle Off	22/52	22/50	15	7.3	151	f)"
Serval Boil Accords	1	13	No	911	3	у:
Missile Kill? Lange 6 Angle 61f	N.	No	11/2	11	11/	#
Terminalis Gen Attach (3000'n)	7.4.4		-10V.Z	2416	ZIRK	
Mich Spood to-To	7	13	16	97	1/2	
Jell Off	17	17	1/2	16	120	₩ ·
Law Speed No-to	1	6.5	1,5	No	16.5	
Ger Kill?	Ý	7	Yes	Yes	200	
I. Difinit - Zeltiai Speed/alettuda	18/2c	25/35	29/20	12/28	2//2	7 -
Herd Turn/Dresk	N N	1/2	ž.	Ż	Z	71 -
Missile Attests Defeated	×	×	Xes	Z Z	Ž	و مد
Maing Spiral	4	7	11/2	110	100	
Tertical Boiling Scissors	4%	4.6	16.	W	11/6	*
Attacker door Seets Speed/alcfrede		1	ļ	20,00	-	Ħ
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- Type attack Initial Spend'altitude Torninal (3X0'h) Spend'altitude High Spend Yo-Ye
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#3 Bath Hispaches Laberdy
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A/S Some as alone except @ lower alt and lower Rolled under their the lowertain But as he solded water their with lowertain But as he standed cours a good traction Situation.

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Lfül that aininge everstoot can be turned to the advantage of the FB6 by getting the target a/c to commit to a spirt and the confidence using a vertical Roll maneuver.

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Sugh ye-yo- Der late and not effective. 3-8/2

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كتيميالالمار التنائل عم حديهما علاودمالا die Esos amited 2 + G to the service to must be the a got of the tribe of actions a way to I courselect in the vert seissors or Def. stid to my dailar thou about some! The ichack his about 11° dure - 1000' Range, Diff, mich so I willed who his boolech + got a aux kill. Noki Target 10 was xwo Cabout inescape iranginec. # = i saurched hom 5 pard elimbing exclut their above Define ly cooseed possible on all attacks intitions in subsite knowly Cocloris but could wat house Inched + his snapped अस्टरमेरीयामे कि किंद्रोंटर महता निका के को लिन का हिन्दिन ending in diving scientimith Burner excape, #2 de la adverse flav. #3 Had on at 3214. 19.1 Devices Chaments #1- Sterrited into dofensive trages OTAS: Describe key factors for each sugasmer stopt agun killgoide Markers (Proments: # Alctode solder me 2 E.K. Turk <u>अन्तर्</u> Past Lengts H. Det عاعماغه

effective, #3 Desd within 15 d. off + 1000 when the barner + pulled up to turn into attacking. I could have kaptgeing in burner + 2500ppd however, attended from the 16/6+ 123 no temps but enable. Attacker to do a Roll off.

ist laver seissons + Flusher FSG

front In Altont to track Alc entered a

Smap underneath & so had to release

pryra

Controls + Fig a diving bunner escape which was

•			Ì	•	rest tematic alectude Mach Level/Man & Alec
The No Type	• 2/7	2	2 2	. Fly then	
3/050		Ť		-	
	Pattennal				NOTES: Describe key factors for each engagement.
it such at		3.	<u>.</u>		Uttacknie / Communitati
type Actively	4/41	1672	Had On.		1 - And two engravments 3-105 married to
latital Speed/Altitrade	04/6	9/25 9	846		all some straight down and he menon a vertical.
Cereivals (Marcila) Spaed/agla Off	.9540	1.85/60 7	None.		Spiral defeat 3-86 transfirm ashillity, Freshim son
larral Boll Account	2		28		2. Ele with Compressed of Suchan mach South went
Cente Kill? Lage & Angle Off	γ_{o}	to	2		26 and wing hall was enomentered, an miching
terrisal: Gas Attack (3000'1)	770	200	6/,000		Touch I ment of 3-86 gets heavy and ofthe must ofter
Ligh Speed Wo-To	770		20		Mereting generalulas Theorthe back and bourbout is mountaine
11 066	Ż	100 9	200		Le Latinas tracking Ly 286 at to hich a hate of chown
or Speed to-To	Z	_	700	_	Cause everator 14 2.86.
An Kill?	700		20		Actedis of emousto:
'ifindit - leitial speed/altitude	.9/35	£020.9	.9/22		Whiteday Portattales relegates then to anhall in land deserted times
land Dara/Jarusia	Med	144 1	Med		Track Otto Coveleged Land range Nother de Post Stoft Sand ton Soudden Per
Mastic attack befores	that	1/40 1	1601		anication of sea heary and found and hot Wender immediately on the
Eving Spiral	140		theal		down to vertical and began a lock ative divine Linal attacher Mound
ertical Belling Scineers	20	570 15	200		Ayender effected asmittenand fiveled ant at seconard 35 mother wood
stacker free Bases Apart/alisterate	Sec /20	-	_		2. Welged to poor deference land twom at 330 the social attacker, choose
Acape Achicounti	740	(10170	160		to give bacype land officted. Vill at 1500-800 (Outendar) mindered distante).
Ma 12.2.3	2h	72	72		With the bith of this lies down and extend dividanial exore to described above
•					"Ottooken, and defenden both by row helling out an time, into so oh other, when
•			•		Var absant. de the last sint the startes desires manner ing (B. Burton in A. A.
					Mondant Other soidentilled hick at to look Milates wand not in

THE MAY - THE RESTOR 657 - ACT 3. (4.)

fly than (JKIL in bianch cross out imaplicable an F. 105.10

Attacke

Initial Speed/Altitude Type Acted 1. derekse Talender ... KARSIVEE LEE

13/ch 58/5 3r/26 | 3rt / 25 Ferminal: Offestie) Speed/angle Off Statio Kill? Range G Angle Off Terratual: Gar Actual (3000'R) served hold accert Ugh Speed To-Yo Lov Speed Yo-Ye Cum 64117 In 13 off

285 Ş Attacker Over Street: Speed/Alchtude Defender - Intefel Spand/aletcude High 'G' Rad Under Massile Attack Defeated Vertical Colling Scianors Iscape Achieved? Mare Dura/Dread biving Spiral

1 5. Trans

#1 Attacker initiated high watch descending siken OTES: Describe key factors for sech engagement.

4 demonstrates occupe that affective achieved seguntar High G Poil Under in Anticipation of affected overshot Brown B + D lost Sight of eachorshop surrel times due gun Kill. Break caused a Hacker to invented and benau but best outsbake speed doing this soldid low seed the of closed to the fembers to concerning distance + clauds, After initial had Robber than fluther down bod a gun altempt, Since at this point defender goted him and con pass attacker zonned then polled under Gercul and Rung Inadiocall and did not begind break until a ilege of him. All had 180xCA3 so derived nose for Sim ació 250-1000 Range as attacken attempted Picane were ferring a Herteire overshoot and olohaman aun kil right of wheckers after missile bill shockers pulled what missile tounch other done for escape when it spinaling supersonic escape. Dépodue conformed a Hackey at 10th and did an impredicte 144, G Pal attack. Defenden missed one-bricked terminal missile 4-2 Attacker in Hobel stean Gta. Attack: delinder Thurse uns soon abolie + behind Def. who had cop stenders turn

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Manile Attack Defeated

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to pross for missile 1 Attacker lost sight of defendent during 6:00 and ochieved 40 ACK - King rshort, Deknober a bich barrel Rbil to four us. Gent offacte Level/Man G Attackex unable Jake Mech M and maneutiered Attack - Hossed heck hard, did diving spind Alctude Wasple S. E.K. Dime Parl Leasts લ CONFIDERTIAL ny thes Utill in bische; seess out inaplicable sur 18/14/25 25/21/80/15 07/9 07 ပိ Š Š Νŝ मिन्ध-उ Tarminal: (Mastle) Speed/lagle Off 2. Hilmin - latchal Speed/alterrate Attaches Over Sheets Speed/alutu Missile fill Lage & Jagle Off AC the Torniball: up Accept (3300'E) Mastla Attack Defeated Vertical Boiling Scioners tattlet most/altimes Larrel Lell Attack Locaps Achievall Mgh Speed Ye-Te Lord Jura/Druss Low Speed You'te Maring Spiral Type Actork Cam Etti? E 1117 10 11 of f Same les 1. secocher.

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			D-L AS HE REVERSED. D-1 LOST SICHT OF FIGHT
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L. Attachen	12 12	, ,	
Type Attack	Titl 6/20		FRONT CF D-1 10 ATT SUMMENSO TO D-1.
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	1		The exists (Leval PAST and A-2.
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Terminals Con Account (2000?)	2/20		#2 (F-100 ATT, F-56-DEF) TO-142 auge
Tigh Man/71and Separation	100 NAV		RT DEF. TURN WITH WIF MAN 1500' @ 6:00.
Man Speed/Lee Speed Me-No	1		A-1 5022 (FIN KILL ON 70-2 (70-1 70)
	Т		NOT SEE A 1+2) A-1+2 EVENTWILLY DIERTING
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Seats of Page Atlant	ON ON		CUN RANGE. F-100'S ONLY CHANGE IN
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ANNEX C

PILOT PLYING EXPERIENCE

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PILOT FLYING EXPERIENCE

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PILOT	AIRCRAFT	TOTAL TIME	TOTAL JET	TOTAL UE AIRCRAFT
A	F-86H	4870	2179	1329
В	F-86H	4786	1729	1121
C	F-86H	2493	1386	1059
D	F-86H	2687	1287	987
· E	F-86H	3211	1829	1061 ·
P	F-86H	3958	2948	1014
F G	F-86H	2624	2184	996
H	F-86H	1083	837	684
Ϋ́Α	F-86H	Unknow n	Unknown	Unknown
I	F-100	2674	2334	1936
J	F-100	2786	2505	1313
K	. F-100	2088	183 8	1695
L	F-105	5097	4142	320
M	F-105	30 83	2779	271
N	F-105	235 3	2059	272
0	P-105	2708	2450	500
P	F-105	3010	2600	570
Q	F-105	2054	1800	652
R	F-104	2000	1750	750
S	F-104	1600	1500	1100 -
T	F-104	1500	1400	625
U	F-104	Unknown	Unknown	Unknown
V	F-4C	6300	4000	530
W	F-4C	4600	4100	250
X	F-4C	3600	3000	170
¥	F-4C	4500	3500	600
Z	F-4C	3100	3000	550

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ANNEX D

F-105 ACCELERATION COMPUTATION

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F-105 ACCELERATION COMPUTATION

Using energy maneuverability terms and Ps values obtained from current Ps-V diagrams (APGC-TDR-64-35 & 38) the acceleration times can be approximated in the following manner. The F-105D is shown in the sample computation.

Terms are as follows:

Ps = Energy rate = specific excess power in ft/sec.

Es = Specific energy in feet.

H = Altitude in feet. $\frac{dh}{dt}$ = rate of climb (ft per sec)

V = Velocity in feet per second.

 $\frac{d\mathbf{v}}{d\mathbf{r}} = \mathbf{a} = \text{Acceleration in feet per second per second.}$

g = Gravitational constant.

From energy maneuverability theory:

$$Es = \frac{V^2}{2g} + H$$

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differentiating with respect to time (T)

$$\frac{dEs}{dt} = \frac{V}{g} \left(\frac{dV}{dt} \right) + \frac{dh}{dt} = Ps$$

or
$$\frac{dV}{dt} = a = \frac{g}{V}$$
 (Ps - $\frac{dH}{dt}$)

assuming an average acceleration:

$$V = Vo + at or t = \frac{V - Vo}{a}$$

For the first case, assume a .95 mach (1010*/sec) attacker detected by an F-105 at 15,000* and 330 KCAS (.665 mach or 706*/sec). Assuming the attacker has no further mach capability, the F-105 will begin to separate when its welocity has reached .95 mach: We*11 assume that the F-105 uses

a level A.B. acceleration in level flight. Ps values for the F-105 (clean, 5000# fuel remaining) in this area average 300 ft/sec. The average velocity during this acceleration is .8 mach. At 13,000 this is 505 KTAS or 854 / sec.

then:
$$a = \frac{32.2}{854}$$
 (300-0) = 11.3'/sec²

the time to accelerate to .95 is then:

$$t = \frac{v - v_0}{a} = \frac{1010 - 706}{11.3} = 27$$
 seconds

If the attacker's average rate of closure during this time (t) is .15 mach (.95 - .8) or 156° per second, the attacker covers 4210° during this 27 seconds. Closure at a rate of .285 mach (304°/sec) should also be added for at least 3 seconds to allow for F-105 afterburner light time, allowing the attacker to cover an additional 912°. Hence, if the attacker is to be maintained at a minimum distance of 3000°, a level A. B. acceleration must be begun under these conditions before the attacker has closed to 8100°. A ½ G diving acceleration can be analyzed in the same fashion. Assume an average descent during the acceleration of 6000° per minute (-100°/second). The average Ps for the above conditions under ½ G loading is approximately 320, hence, a = $\frac{32.2}{854}$ (320 +100) = 15.8°/sec²

and $t = \frac{1010 - 706}{15.8} = 19.2 \text{ seconds.}$

0

During this time, the attacker would close 2990°. Adding the 912° of closure during 3 second A. B. light time, if the attacker is to be maintained at a minimum distance of 3000° then the ½ G diving acceleration must be begun before the attacker has closed to 7000° range.

ANNEX E
PARTICIPATING TEAM

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F-86H TEAM SUMMARY OF MISSION FF-857

WRITTEN BY LT/COL JOSEPH J. MAISCH, JR.

- 1. The F-86H can successfully defend against both missile (AIM-9) and gun attacks by the F-100, F-105, F-104 and F-4 as long as he is aware of their presence before they reach effective firing range. After defending against this gun attack from within 3000 ft range, the F-86H will probably get a gun kill on the F-100 or F-105 (unless the F-105 has .95 mach or better). The F-104 and F-4 can escape in the reversal if their speed is .9 or higher, otherwise, the F-86H stands a chance of a quick gun kill during the F-104 or F-4 separation maneuver. The F-86H has a better chance for a kill if ceached, on when to reverse, by a properly positioned wingman (4000 to 5000 abreast or slightly aft).

 2. Of the four century types, only the F-100 has any chance at all of escaping the F-86H when fighting the obsolescent ACM game; and this F-100 pilot must be of FWS instructor caliber.
- 3. The F-100 and F-105 have not been successful in escaping from an F-86H gun attack when the evasive maneuvering was started at 4500 feet or less range. The F-104 and F-4 can escape this attack from as close as 3000 ft range, but only if they start the separation maneuver immediately. The only successful separation maneuver is the one whereby they start an unloaded (+1/4 to 0 G) quarter descending roll, attempting to spoil the attacker's tracking problem by reversing roll direction in the descending plane and using minimum positive G while separating at the maximum possible rate. The F-86H will normally decrease the range by 1000 1500 ft while the F-104 or F-4 is performing the initial part

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of the separation maneuver, but will be unable to track if the defender performs properly.

- 4. The F-104 has a definite advantage in that he is very difficult to acquire visually due to small profile, and once acquired difficult to keep in sight. Also, when the 104 rolls into a bank it is very difficult to determine the direction in which he is turning or will turn. The 104 is extremely difficult to see when making a head-on pass.
- 5. The F-100 and at times the F-105 can cause the F-86H to overshoot from a stern type pass. The amount of overshoot is of course determined by the closure rate. This overshoot however, is merely a delaying action because the F-86 can yo-yo high, watch the next move by the defender and then either roll over the top or slide down into the 6 o'clock.

 The F-4 and F-104 cannot normally cause the F-86 to overshoot.
- 6. The F-86H is capable of pulling up into a whifferdill type maneuver to almost zero airspeed without snap type maneuvers resulting, and will then accelerate very well in the downhill run.
- 7. The F-86H has one very definite limitation in the .91 to .96 range and that is its tendency to roll to the right. This makes rolling to the left very difficult, and tracking during this wing roll is just about impossible.

F-104 TEAM EVALUATION OF F-104 VERSUS F-86H

1. F-104 Defender, F-86H Attacker:

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- a. At almost any range and any reasonable cruise airspeed for that altitude, the F-104 can escape if he does it correctly (regardless of the attacker's range).
- b. Never pull up into the attack or try to break or hard turn level as a defensive maneuver.
- c. A flaps up, full afterburner, diving low G spiral is an almost fool-proof escape maneuver. It is extremely difficult to track and lateral separation is rapidly attained.
- d. If the attacker has closed into 1500 fest and, for some reason, has "missed," he can be forced into an overshoot if he has any appreciable overtake speed. The F-104 will decelerate faster but the overshoot is only momentary and at best gives an opportunity to break down and away as the attacker rolls over the top for repositioning. (Not a useful maneuver in any but a super last ditch attempt to get away from an attacker who has run out of ammo!)
- e. Starting a mission at the same time, the F-104 can spar with an F-86H attacker in the trans-sonic region and run the attacker out of fuel.
- f. In rolling down and away for exparation from an F-86H, it is best to go to the left as this amplifies the attacker's wing roll tendencies and complicates his tracking problem at higher mach numbers (.92+).

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- 2. F-104 Attacker, F-86H Defender:
- a. In attacking with the F-104 the only real offensive strength other than the superior speed is the fact that the F-104 is difficult to see (especially in the headon profile) and it is difficult to judge range and closure rate.
- b. If the defender makes a hard turn at ranges of 5000 feet or less the F-104 can make a gum kill before sufficient angle off is generated by the defender. This is providing the attacker is supersonic. At subsonic speeds the attacker is able to track longer but is not able to close into gum range before the large angles off are generated. It is therefore no advantage to slow down to enhance turn radius and tracking time. The escape is about the same since at higher overtake speeds, the defender has generated less turn prior to his reversal; on the lower speed pass, the defender has turned farther so has less airspeed himself and has a larger angle to reverse through before he poses a threat to the attacker.
- c. If the defender breaks into the attack at ranges outside of 4000 feet it is not possible to track for a gun kill. The escape is no problem since the defender has lost all airspeed and has generated great angles off.
- i. At low altitudes the F-104 can zoom away from any subsequent gan attack after the overshoot but is in a position for a possible missile attack by the defender.
- e. If the F-104 does not have to defend against missile attack, it can stay in the combat area and spar with the F-86 making high speed

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attacks against the defender and possibly get a successful gun attack or a surprise deep six attack, if the F-86 loses sight of his attacker. In any case the F-86 could be kept engaged until fuel considerations required the F-104 to leave the fight.

- 3. (ACT-5) F-104 Defending Element versus F-86H Attacking Element:

 The F-104 performed defensive split with the F-86 closing from a stern quartering attack. The defensive split was only effective in that it delayed the final positioning of the F-86. In order for either F-104 to escape both must perform the diving sprial type of escape.

 The defensive split is not an effective maneuver to perform against the F-86H. If the F-104 defenders are fortunate enough to spoil the attackers at a mile, it is mandatory to immediately dive out of the fight rather than attempt any other maneuver, and then attempt to engage on more favorable terms.
- 4. F-104 Attacking Blement versus F-86H Defending Blement:

On ACT-6 we had time for two passes and both passes were run under the same parameters. F-86H at 35000 feat and .88 uach, the F-104 at 35000 feet and .90 mach. The attack was initated from 4 o'clock position about five miles out.

We discounted the value of element close formation tactics so on the initiation of the attack the wingman slid out about 30 degrees from the lead and did a max acceleration low G rum on this heading. The lead attacker began a slow turn flying a pursuit curve and accelerated to .98. As the lead closed in to about a mile the number two attacker commenced his turn in. Shortly thereafter the defenders did a defensive split.

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They performed it perfectly with the #2 defender calling the reversal as the attacker overshot. Since the wingman was obviously pulling less G's he was tracked for a few moments before the F-104 was forced to break off in the overshoot. The lead defender immediately reversed and the wingman rolled under but the attacking F-104, with approximately .95 mach, spiraled down and to the left with no real difficulty in achieving separation. About this time the #2 attacker made his tracking pass and had a clear shot at either defender. He then pulled off and rejoined lead.

During this attack the defenders were unable to pick up the attacking lead until he was in about one mile. He therefore called off his range and angle off. They never did pick up the number two man.

After the breakaway the lead F-104 pulled up sharply about a mile ahead of the pursuing F-86's and at 1.3 msch. Within 30 seconds the F-86's were in gun range and tracking on the zooming F-104. This confirmed earlier findings that after accomplishing a successful escape maneuver it is unwise to zoom up and try to return immediately to the combat area.

On the second pass the same results were achieved, however, the attackers did not get enough lateral separation and the \$2 attacker was in the attack too early and had little time to track, if any. He did distract the defenders and caused them to lose sight of the lead actucker who had commenced his dive for separation. On observing the defenders reverse back after the \$2 attacker, the lead rolled out and soomed back

up immediately into the six o'clock of the defending flight. As he was completely unobserved he had no evasive action to contend with at this time.

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On both attacks the attack would have been enhanced had the lead attacker accelerated to 1.05 or 1.1. A speed differential of .35 between the two attackers is just a little too much and a superfunic pass from any quarter was found earlier to be most advantageous for the attacker.

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SUMMARY OF THE F-4C PORTION OF TAC MISSION FF-857

Program FF-857 was established to determine optimum offensive and defensive tactics for the F-4C when confronted with highly maneuverable, but subsonic aircraft of the MIG 15/17 type. Air National Guard F-86Hs were the closest available approximations to the desired maneuvering and performance characteristics and were used as adversaries throughout the evaluation. The specifics of the program were defined by the USAF Fighter Weapons School, under the direct supervision of Colonel James C. Hare, Commandant, with Captains Muskat and Williams as project officers. Three F-4Cs with five pilots, one maintenance officer, and fourteen maintenance support personnel were provided by the 4453 CCTW for the period 2 May - 7 May at Nellis AFB, Nevada. Lt Colonel R. S. Parr commanded the F-4C detachment and functioned as F-4C project liaison with the Fighter Weapons School.

The Evaluation as planned by the fighter weapons project officers required sixteen flights, broken down as follows:

Air Combat Ta (3 Sorties)	ctics I -	F-86H vs F-4C (Gun Attack)
ACT (3 Sorties)	11 -	F-4C vs F-86H (Cun Attack)
ACT (3 Sorties)	111 -	F-86H vs F-4C (Missile Attack with Follow-up Gun Attack)
ACT (3 Sorties)	IV -	F-4C vs F-86H (Missile Attack with Follow-up Gun Attack)
ACT (2 Sorties)	٧ -	2 F-86H vs 2 F-4C (Evaluate Element Defensive Tactics against Gun Attack)
ACT (2 Sorties)	VI -	2 F-4C vs 2 F-86H (Evaluate Element Offensive Tactics for a Gun Attack)

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There was allowance for additional sorties, if needed, to further validate or investigate findings on any of the previously flown sorties.

As flown the project required eighteen sorties, the two additional flights were to further substantiate the findings on ACT I and ACT III.

ACT V and VI were combined and accomplished on the final flight because the F-86s were forced to air abort on ACT V when one of their aircraft experienced a minor emergency on climb out.

SUMMARY BY MISSION TYPE

ACT I:

- a. With the F-4C simulating Combat Air Patrol at 35,000°, .85M, the attacker closes to approximately 4,000-5,000 feet, 10°-15° angle-off, at .94-.97M prior to any defensive maneuvers by the F-4C.
- pushing to approximately 0 to ½ "G", simultaneously advancing to maximum power while rolling approximately 60° bank angle into the attacker. This resulted in a rapid acceleration to co-speed while the attacker closed an additional 1,000° to 1,200° them an ever increasing separation to well out of effective gun range. The length of time at 0 to ½ "G", thus allowing maximum acceleration, is a function of aircraft limitations, attacker range at initiation and attacker closing rate.
- b. F-4C simulating cruise with load at 20,000, .78M, otherwise same as previous encounter.
- (1) Essentially the same as 35,000, but it is imperative that any high drag/heavyweight stores should be dropped immediately. Additional measures such as rolling or "jinking" while separating from attacker would severely limit his ability to track at long range.

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ACT II:

- a. F-86H at 35,000°, .83M, F-4C initiates stern quarter gun attack, F-86 commences evasive meneuvers at 4,000-5,000° attacker range.
- (1) Although the F-4Cs were on the offensive for this mission, the F-86s were tasked with: 1. escaping, and 2. attempting a gun or heat missile attack when and if the F-4Cs overshot.

If the F-86s initiated proper evasive maneuvering well prior to F-4C gum range they invariably escaped. If they misjudged closure rates and delayed their evasive maneuvering or reversed too soon on anticipated overshoot, they could be tracked and probably destroyed. It was imperative for the F-4s to keep their mach up throughout the attack to achieve escape after overshooting. If the F-4 slowed and attempted to maneuver with the F-86, they were extremely vulnerable. The optimum mach for the F-4s appeared to be approximately 1.0-1.1M. This kept closure rates to a reasonable value, and still allowed either a successful maximum afterburner climbing departure or quarter roll descending break when tracking was no longer practical. In this phase, mach must not be sacrificed in attempts to out-maneuver the adversary.

- b. F-86 at 20,000, .8M, F-4C initiates stern quarter gun attack.
 F-86 commences evasive maneuvering at 4,000-5,000 attacker range.
- (1) Same comments as above.

ACT III

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a. 'F-4C at 35,000', .85M simulating CAP. F-86H initiates stern quarter heat missile and follow-up gun attack. F-4C defensive maneuvering starts when attacker at 6,000-7,000 foot range.

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- defeat the missile attack it is necessary to turn into the opponent, to defeat the gun attack requires separation. A level, or nose high, maximum afterburner, hard turn into the attackers would preclude a successful missile attack but would permit closure and a successful gun attack. The optimum defensive tactic appeared to be an immediate, nose low, maximum afterburner turn into the attacker. Approximately 30° nose down with not more than three "G" initially would allow acceleration, but still shrink the missile envelope enough to defeat the missile attack, while the acceleration effectively separated from the F-86 and precluded a successful gun attack. A further roll reversal underneath achieved maximum separation rate, but did not seem to be necessary. Premature zooms, after initially escaping, would probably result in a successful missile or gun kill by the opponent if he pressed the attack.
- b. F-4C at 20,000°, .78M simulating heavyweight cruise. F-86 initiates stern quarter heat missile and follow-up gun attack.
- (1) Same as above, but the reduced altitude preclude any steep accelerating, moderate "G" roll unders after the initial phase.

 ACT IV:
- a. F-86 at 35,000', .82M, F-4C initiates heat missile attack from stern quarter with follow-up gum attack.
- (1) Essentially the same as ACT II. Barrel roll attacks for an optimum heat missile launch were astempted, but the superior maneuversbility of the F-86, and the extremely limited capabilities of the Sidewinder against a maneuvering target precluded success.

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ACT V:

- a. Two F-4s simulating CAP at 35,000°, .86My two F-86s initiate stern quarter gum attack. F-4s commence defensive maneuvering at approximately 4,000-5,000°.
- (1) For adequate mutual support it is essential for the defenders to maintain line abreast. Early recognition of the attackers as to type, range and closure rate allowed adequate defensive maneuvering to preclude a successful gum attack.

ACT VI:

- a. Two F-86s simulating cruise at 35,000°, .82M; two F-4s attack from stern quarter.
- (1) Essentially the same as ACT II. Because of the mutual support aspect of this mission it is feasible to press the attack further. Optimum element tactics could not be established on the basis of a single flight.

GENERAL COMMENTS:

In preparation for the evaluation, the texm leader initiated discussions among the F-4 pilots to establish principles and compare capabilities of the F-4 and F-86H. Although specific performance and maneuvering data were not available for the F-86H, experience verified by rough calculation immediately established the decided maneuvering adventage of the F-86 at indicated speeds of 400K and below, and at the altitudes to be used for the program this was the applicable envelope. This was translated into the first principle:

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(1) It is pointless to attempt outturning the F-86 with the F-4C as presently configured. It is conceivable, however, that a supplemental lift device could improve the F-4C's turn capability and make it competitive with the F-86.

Since the F-4C cannot out-maneuver the F-86, the second principle logically followed:

(2) When attacked, the F-4C should immediately strive for separation and re-enter the flight on its own terms.

The performance comparison included the obvious fact that the F-86 was mach limited to approximately 1.0, and then only in a steep dive.

Further discussion and calculation indicated a decided advantage in thrust to weight ratio in favor of the F-4C. This fact has to be tempered with drag considerations, since excess thrust to weight ratio determines performance capabilities. This ratio is greatest at the best climb speed for any given altitude, which closely approximates .9M for the F-4C in the configuration and at the altitudes flown. In view of the drag characteristics associated with low aspect ratio, high wing loaded aircraft, any maneuver which increases lift greatly increases drag and therefore decreases excess thrust.

It logically follows that any actions which maximize excess thrust assist in achieving the desired separation. If the aircraft is "unloaded" to 0 to k "G", drag is minimized, excess power increases and maximum separation rate is achieved. If it is essential to turn into the opponent to defeat a missile attack "G" must be applied sparingly and the nose allowed to drop (at medium and high altitudes) to

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allow acceleration and thus separation. Operation at M below that for best climb represent a loss in efficiency, allow the attacker to close further and increase the speed differential, thus time thru which the defender must accelerate. This leads to the last principle:

(3) Keep your mach up.

The higher your initial mach, the less closure rate for the attacker, and the more time available for sighting and/or maneuvering.

The flights conducted throughout the program indicated several areas for further development or investigation.

- a. The Sidewinder (AIM-9/B) is severely limited when employed against a maneuvering target.
- b. There is a definite need to develop Sparrow III employment tacics against maneuvering target without a GCI environment; the range capabilities of the missile greatly exceed the visual identification envelope.
- c. Aft visibility from the F-4C is severely restricted by the "flush" canopy design. Removal of the aft cockpit instrument hood assists slightly, and the installation of mirrors in the aft cockpit also assists, but even with these changes it is still very poor.
- d. A lift supplement, such as maneuvering flaps, could greatly increase the ACM potential for the F-4C.
- e. The trim change gradient associated with airapeed changes, and the relatively slow trim response of the F-4 make maximum performance maneuvering difficult.
- f. Currently established flight tactics should be thoroughly reviewed and validated.

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- g. If the F-4 is to be employed as an air superiority weapon, a moduled gun and a pilot controlled computing sight are essential.
- h. If the roll damper in the F-4 is not precisely adjusted, it can cause unnecessary tracking difficulties. A pilot selected roll damper would eliminate this limitation.
- i. The automatic shoulder harness lock installed in the Martin

 Baker seat severely limits pilot mobility when maneuvering. Again, a

 selective cutout of this feature would be highly desirable.
- j. The almost complete lack of a vigorous ACM program throughout the Air Force severely limits our potential. ACM takes practice and judgement, proficiency cannot be achieved by reading manuals and theorizing. The risks inherent in maximum performance maneuvering can be minimized by education and supervision. Unrealistic limitations would defeat the fundamental purpose.
- k. The scope of TAC Program FF-857 was too limited. ACT against like aircraft, simulating MIG 19, MIG 21, etc. should have been included.

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ANNEX P

ACT MANEUVER DIAGRAMS
AND
EXPLANATION

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ACT MANEUVER DIAGRAMS AND EXPLANATION

1. HIGH SPEED YO-YO (Figure 1)

The high speed yo-yo is an offensive maneuver in which the attacker manervers through the vertical and horizontal planes to prevent an overshoot in the plane of the defender's turn. When an overshoot appears imminent, the attacker pulls up into vertical plane, so that nose tail separation can be maintained. Afterburner should be employed as required (especially in F-105) to maintain some closure. At the slower speed in the apex, a turn is made to realign with the defender's 6 o'clock position.

2. LOW SPEED YO-YO (Figure 2)

The low speed yo-yo is an offensive maneuver which provides turn cut-off and closure speed in a Lufberry turn, or increased closure rate in a running battle. To gain position quickly, with this maneuver, the attacker lights the afterburner and dives below and inside the defender's flight path, and then pulls up to zoom at the defender and either pulls into his turn, or executes a follow up high speed yo-yo if the angle off is too high.

3. THE SCISSORS MANEUVER (Figure 3)

The scissors is a defensive maneuver in which a series of turn reversals is executed in an attempt to achieve an offensive potential after an overshoot by an attacker. Success, when employing the scissors maneuver, depends on the defender's ability to achieve a lower velocity component in the direction of the flight, using a large amount of turning and rapid speed reduction.

4. VERTICAL ROLLING SCISSORS (Figure 4)

The vertical rolling scissors is a defensive raneuver which is used when a defensive turn in the vertical plane causes the attacker to overshoot. The defender then reverses into the attacker, and continues a high G rolling maneuver to force the attacker out front.

5. BARREL-ROLL ATTACK (Figure 5)

This offensive maneuver can be effectively employed when approaching a defender at high angle off and long range. If a high speed yo-yo is employed under these circumstances, the attacker is forced to an extremely high apex in order to maintain nose-tail separation and stay inside the defender's turn radius. The barrel-roll attack allows the attacker to reduce his velocity, cut-off and turn inside the defender's turn, then regain velocity after angle off is diminished.

6. HIGH G BARREL-ROLL (Figure 5 & 6)

The high G barrel-roll is a "last ditch" defensive maneuver which is used to force the attacker out front. The maneuver is a max performance, vector roll designed to rapidly reduce aircraft indicated airspeed and vector velocity. The roll can be made in the direction of the turn (under) or following a reversal (over). The high G barrel-roll over the top is performed if an attacker is detected with low rate of closure at gun range, and the defender knows that a break would not be successful. The maneuver requires a high angle of attack capability at slow speed and is generally not suitable for F-104 type (high horizontal text surface) aircraft. For the F-105, since control response is sluggish and airspeed bleed off rapid, the maneuver is not recommended. The high G roll under

is performed if low airspeed does not permit execution over the top, and as a last ditch maneuver for F-105 aircraft. In the F-105 aircraft, rapid speed bleed off plus an approximate 5000° altitude loss will result. The high G roll under is entered with a rapid roll to the inverted position.

7. DIVING SPIRAL (Figure 8)

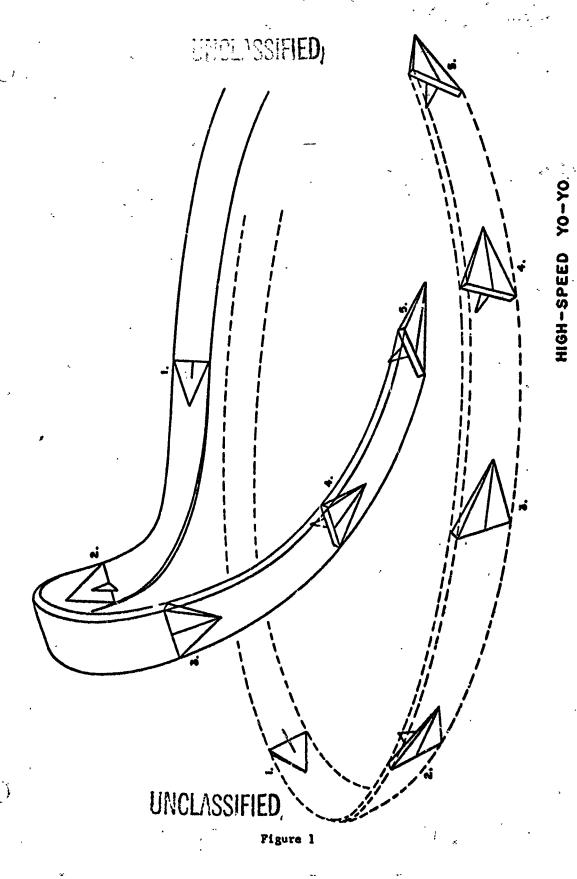
The diving spiral is performed as a last ditch maneuver designed to prevent gun or ADM-9/B type missile kill while the defender is gaining airspeed for separation, or to perform a reversal up into the attack. Entry to the diving spiral is similar to the high G roll under. From the inverted position the aircraft is pulled into a vertical spiral or a spiral with a lesser axis of descent, depending on altitude available. Max power is used and moderate G is combined with a rapid roll rate to defeat the attacker's tracking. The increasing airspeed will increase both acceleration and G capability. As airspeed builds, G is relaxed to allow further airspeed increase for separation.

8. DEFENSIVE SPLIT (Figure 9)

The defensive split is performed if an element is attacked and cannot achieve separation or turn to meet the attack. A defensive turn is held to defeat the AIM-9/B type missile attack. As the attacker(s) close for a gun attack, the defending element leader calls the split as the attackers approach gun range. The low defender continues a hard turn or increases to a break se required and the high defender slides high to acquire a line abreast position in the vertical and horizontal plans, with about 3000-4000° separation. The object is to force the attacker(s) to

commit themselves to one of the defenders. Once the attacker commitment has been made, the defender under attack maneuvers as required to stay alive, and the free defender effects a "sandwich", with the attacker(s) in the middle. Several options are available depending on the attacker(s) commitment.

9. For full information on Air Combat Tactics Maneuvers, refer to USAF Fighter Weapons School Lesson Plan 50-10-60 "Aerial Attack Study".



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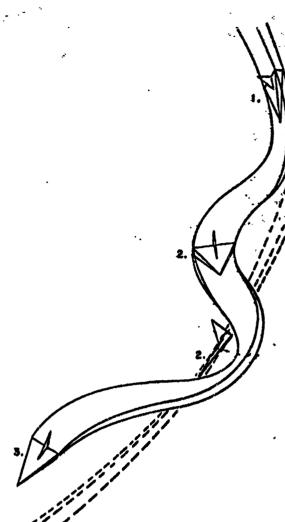
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Figure 3

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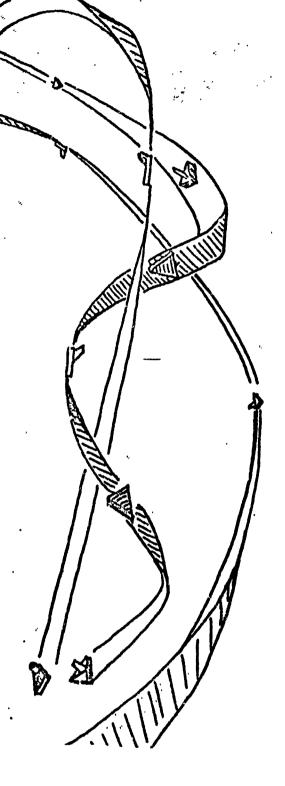


VERTICAL ROLLING SCISSORS

Figure 4

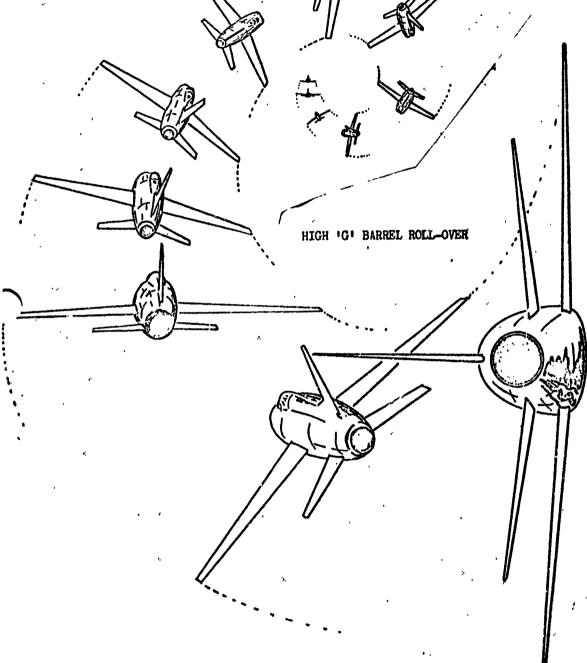
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Figure 6

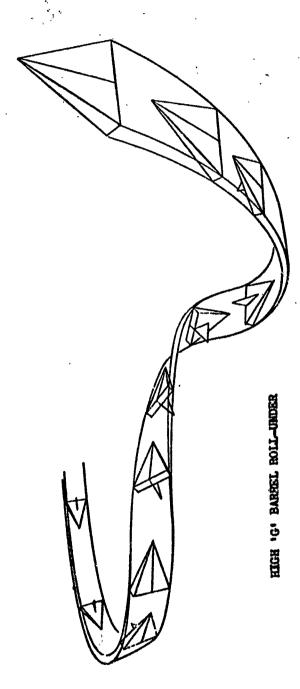


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DIVING SPIRAL

Figure 8
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DEFENSIVE SPLIT

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ANNEX G BNERGY MANRIIVERARTITES

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ENERGY MANEUVERABILITY MAXIMUM SUSTAINED G CAPABILITY

- 1. During the first week of the evaluation, F-86H, F-100D, and F-105D aircraft performed thrust limited level turns to spot check maximum sustained G values at the zero Ps point (level flight) shown on the PsV energy maneuverability charts contained in this annex. These checks were performed at selected indicated machs, and for the F-86H and F-100 .02 mach was added to the recorded speeds to obtain a true mach reading with which to enter the PsV charts. F-105 aircraft cockpit mach indication is in true mach.
- 2. To gather such data, pilots climbed to either 15,000° or 35,000°, as briefed, acquired the specified indicated mach in level flight and then entered a level turn, advancing power to the specified setting as G was increased. The turn was then held as tight as possible without encountering speed or altitude loss, and average cockpit G meter readings were recorded through a stabilized turn of 90° 180°.
- 3. This data is presented in Table 1. The values listed under "Predicted Max G" are from the PsV diagrams in this annex for the specified aircraft, true mach, and altitude. For the F-86H, there are presently no PsV charts. For purposes of comparison, corresponding values for the MIG 17 (AB power) are shown in the "Predicted Max G" column for the F-86H entries. The PsV diagrams were computed for 50% of internal fuel remaining. Such amounts of fuel for each type of aircraft are as follows:

F-100 - 3900# F-105D - 5000#

F-86H - 1800#

The actual fuel remaining at the time the data was recorded is presented, since some degradation or improvement in performance would be reflected

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with variation 'n fuel remaining.

- 4. It must be emphasized that the recorded data is presented only as a guide, in that inaccuracies could be attributed to any or all of the following factors. Data was observed visually by the pilot and recorded on a knee board.
 - a. Pilot technique.
 - b. Cockpit instrument insccuracy.
 - c. Variations in thrust.
 - d. Wariation in fuel on board.
 - e. Non-standard atmosphere conditions.
- 5. It should be noted that the values computed for the MIG 17 in AB power exceed in all cases the values recorded for the F-86R.
- 6. At the present time a full test on verification of EM data is being conducted at Eglin AFB, utilizing instrumented aircraft and more exact testing techniques.

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TABLE 1

			* •			•
Type Aircraft	Altitude	True <u>Mach</u>	Power Setting	Recorded Max G	Predicted <u>Kax G</u>	Fuel Re- meining/#
F-100D	35,000	.92	MIL	1.2		5200
F-100D	35,000	.92	Mil	1.2	2.0	5200
¥-100D	35,000	.82	MIL	1.5		5100
F-100D	35,000	.82	MIL	1.5	1.9	4800
F-100D	35,000	.92	MAX	2.3 ·		5000
F-100D	35,000	.92	MAX	3.0	2.6	4800
F-100D	35,000	1.12	MAX	2.0		3800
F-100D	35,000	1.12	MAX	2.5	1.3	4900
F-100D	15,000	.82	MIL	3.0	3.5	3000
F-100D	15,000	.92	MIL	1.0		4500
F-100D	15,000	. 92	HIL	1.0	2.2	450 0
F-100D	15,000	.82	MAX	4.5	5.0+	3820
F-100D	15,000	.92	MAX	3.5		3300
F-100D	15,000	.92	MAX	3.5	5.0+	4400
F-105D	35,000	.8	HIL	1.3	1.2	2300
F-105D	35,0001	.9	MIL	1.4	1.3	7100
#-105D	35,000	.8	XAK	1.75	1.5	7200
F-105D	35,000	.9	MAX	2.0	1.9	7000
F-105D	35,000	1.1	MAX	2.0	2.0	6900
F-105D	35,000	1.3	HAX	2.1	2.0	5500
F-105D	15,000	.7	MIL	2.5	2.3	3500

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Type <u>Aircraft</u>	Altitude	True <u>Mach</u>	Power Setting	Recorded Max G	Predicated Max G	Fuel Re- maining/#
F-105D	15,000	. 8	MIL.	2.7	2.6	3300
F-105D	15,000*	.9	MIL	3.2	3.0	3200
			•			
F-86H*	35,000'	.72	MIL	2.0		2200
F-86H	35,000	.72	Mil	2.5		2600
F-86H	35,000*	.72	MIL	2.2	(2.8)	2000
F-86H	35,000	.82	HIL	2.2		2100
F-86H	35,000	.82	MIL	2.6		2600
F-86H	35,000	.82	MIL	2.0		1800
P-86H	35,000'	.82	MIL	1.9	(3.0)	3200
P-86H	35,000	.92	HIL	1.6		2200
F-86H	35,000*	.92	MIL	1.1		1600
P-86H	35,000	.92	NIL	1.6		3300
y- 868	35,000	.92	MIL	1.75	(2.8)	2200
P-86H	15,0001	.72	MIL	5.0 +		1500
7-86H	15,000	.72	Mir	4.5 - 5.0		1600
F-86H	15,000*	.72	MIL	5.5		2400
F-86H	15,000	.72	MIL	5.0	(5.0+)	•
y-8 6H	15,000	.82	MIL	4.5		1700
P-86 R	15,000	.82	MIL	4.5		2300
P-86H	15,000*	.82	MIL	4.7	*	1700
7-86R	15,000*	.82	HIL.	4.0	(5.0+)	•
r-86H	15,000	.92	MIL.	2.5		1700

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Type <u>Aircraft</u>	Altitude	True <u>Mach</u>	Power Setting	Recorded Max G	Predicted Max G	Tuel Re- maining/#
F-86H	15,000	.92	MIL	1.3	* **	1500
F-86H	15,000	.92	MIL	1.8		•
F- 86H	15,000*	.92	HIL	2.75		2260
F-86H	15,0001	.92	HIL	3.0	(4.3)	1600

*Note variation between individual F-86H readings, particularly at .92 mach and 15,000°.

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ENERGY MANEUVERABILITY THEORY

- 1. <u>DEFINITION OF TERMS</u>: Energy Maneuverability Theory is a system of quantitatively relating the performance of different aircraft at any airspeed or altitude. For use of this theory in tactics evaluation and performance comparison, two basic concepts are involved.
- a. Specific Energy Level: This is a measure of the energy possessed by a fighter as a result of its position at a particular speed and altitude. A fighter with a high Specific Energy Level has an advantage in speed and/or altitude over one with low Specific Energy Level. Hard mareuvering especially at high altitudes, normally causes a Specific Energy Loss, hence it is to the advantage of an attacking aircraft to initiate the attack with a higher energy level than its opponent. The attacker can afford then to trade this energy while maneuvering for position.
- b. Specific Excess Power or Energy Rate: Energy rate is a measure of the time rate at which a fighter gains or looses energy and is equivalent to the specific excess power of that fighter. Specific excess power is that amount of extra power possessed by the fighter after the normal power required merely to "stay in the air" has been subtracted. In other words, it is a measure of the extra power available to climb, accelerate, or turn tighter as required by the measurements situation. A positive energy rate, thus indicates capability for gain of speed, altitude, or G, while a negative rate indicates that the fighter must lose speed and/or altitude or it must relax the G load.

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Es = Specific Energy = $h + \frac{v^2}{64.4}$

Es Units in feet

h = height in feet

V = velocity in feet per second (true airspeed)

Ps = Specific excess power = energy rate

Ps Units in feet/sec

- 2. PSV DIAGRAM: Refer to figure 10 and note the following.
- a. At .8M, pulling 5 Gs, the F-104 and MIG 21 are an even match.

 Both have a positive Ps of approximately 325 ft/sec. The specific excess

 power (energy rate) can be used to increase altitude, airspeed, or turn (G).
- b. At 1.1M, pulling 5 Gs, the F-104 has a negative Ps of 220 and the MIG 21 has a negative Ps of 150. Both aircraft are losing energy, but the F-104 is losing it faster.
- c. The F-104 has an advantage (sea level) from .7 or .8M to slightly over mach one.
- 3. HV (Energy Rate) DIAGRAM: Refer to figure 11 and note;
- a. At 45M, 1.35M, the F-104 and MIG 21 are an even match. Both aircraft have a positive Ps of 100 ft/sec. This Ps can be used to increase altitude, airspeed, or turn (G).
- b. At 48M, the max steady state much number for the F-104 is 2.0. At the same altitude the MIG 21s max velocity is 2.2M.
- c. At 1.3 or 1.4 to mach 2.0 the F-104 enjoys an advantage at all altitudes, since the solid (F-104) lines fall above the dotted (MIG 21) lines.

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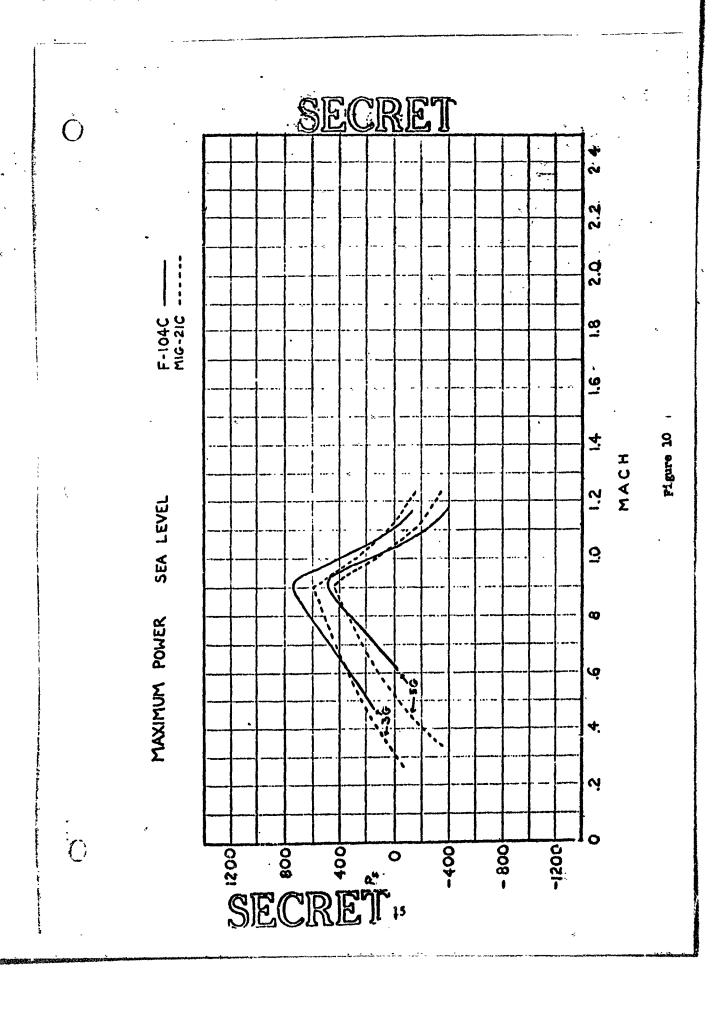
For more detailed information on Energy Maneuverability Theory, refer to:

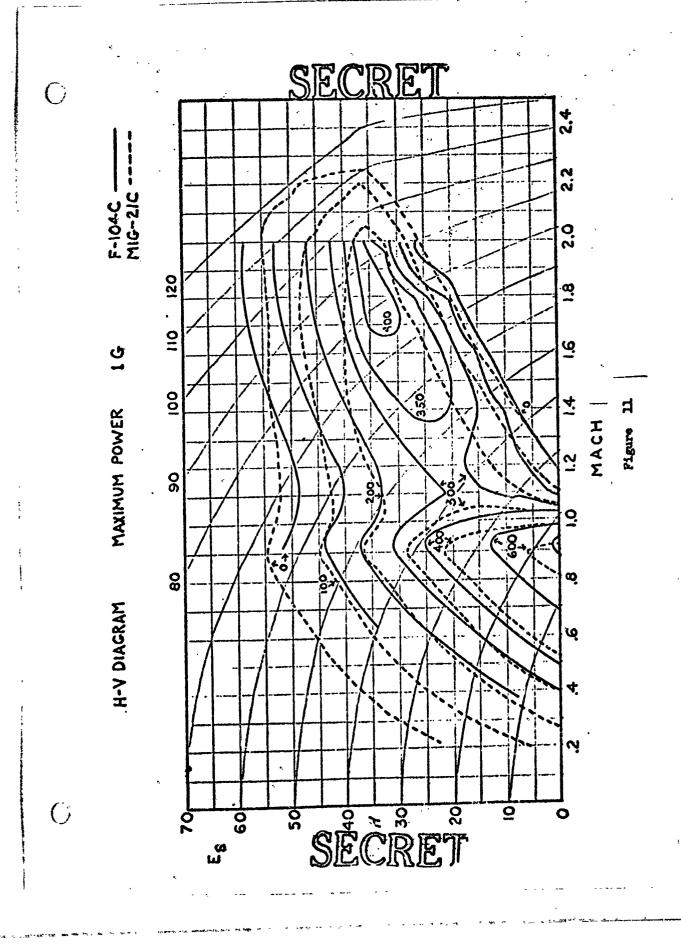
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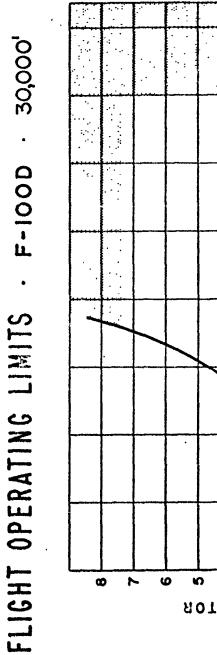
Fighter Weapons School Lesson Plan - "Fnergy Maneuverability" 50-10-6e.

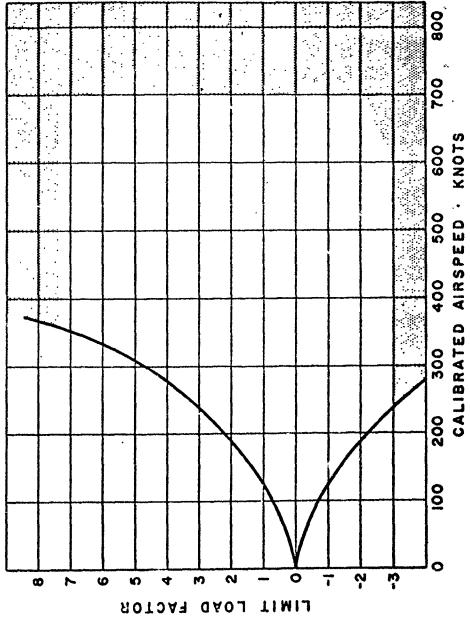
4. Energy Maneuverability diagrams are included in this armex to allow comparison of energy rate capabilities of the participating TAC Fighters and the MIG 15 & 17.

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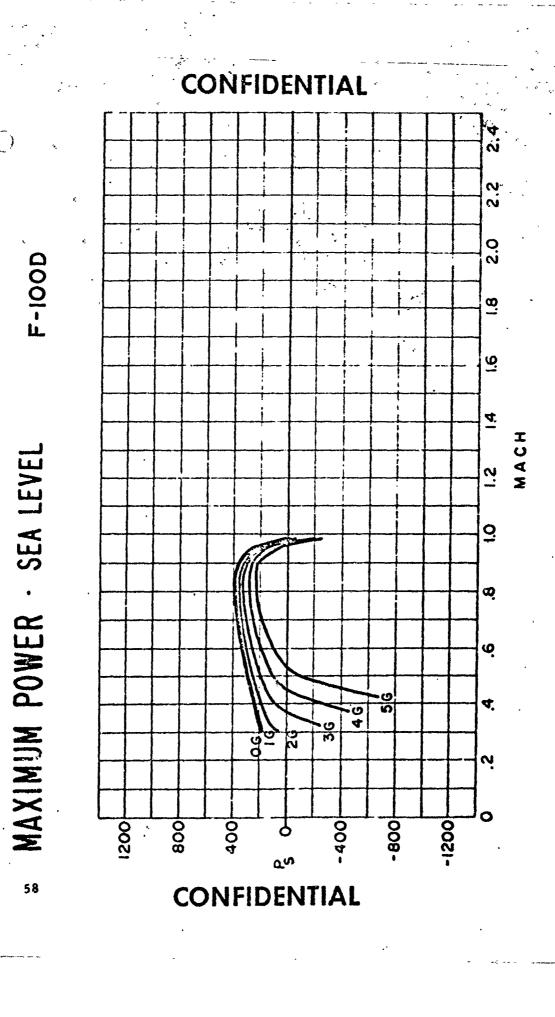


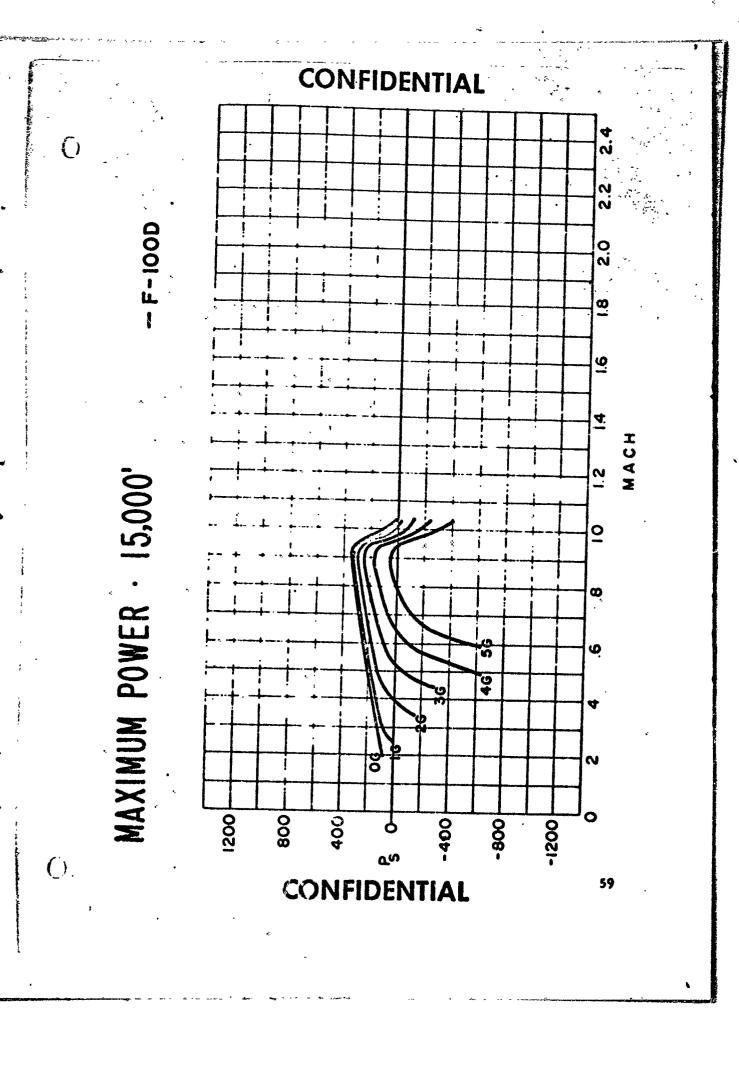


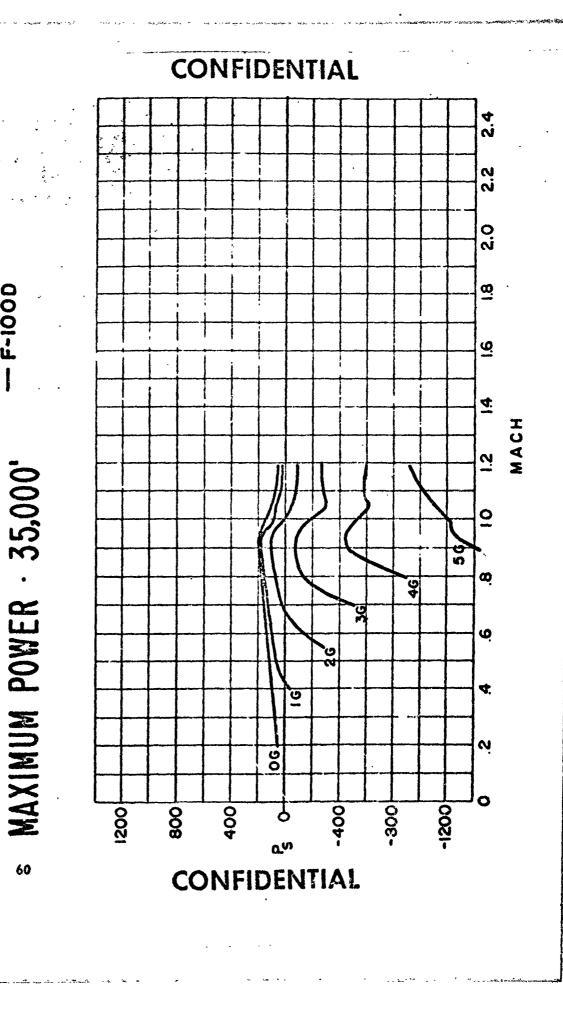


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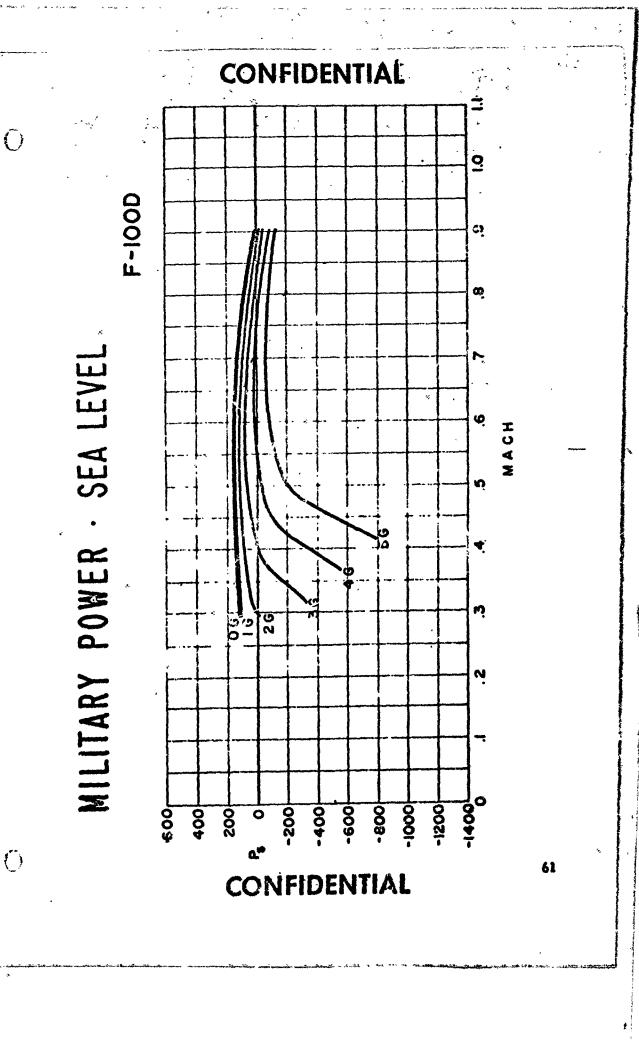
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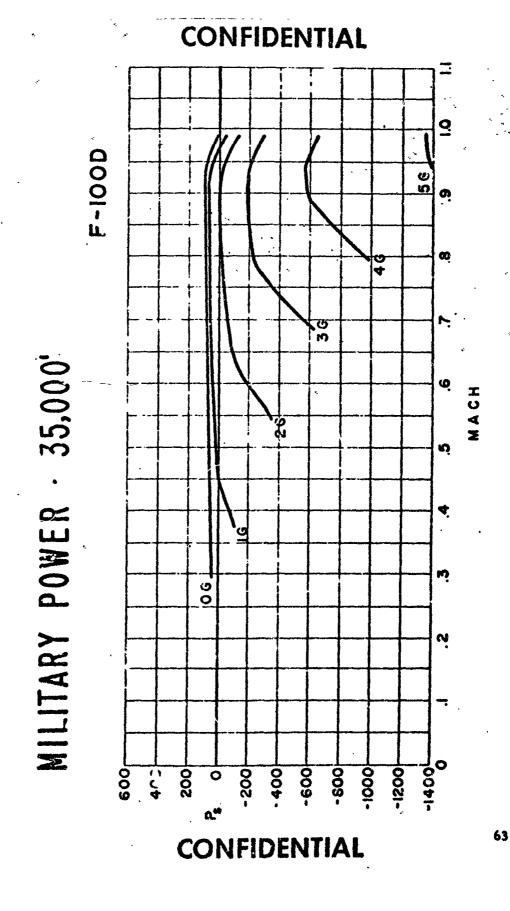
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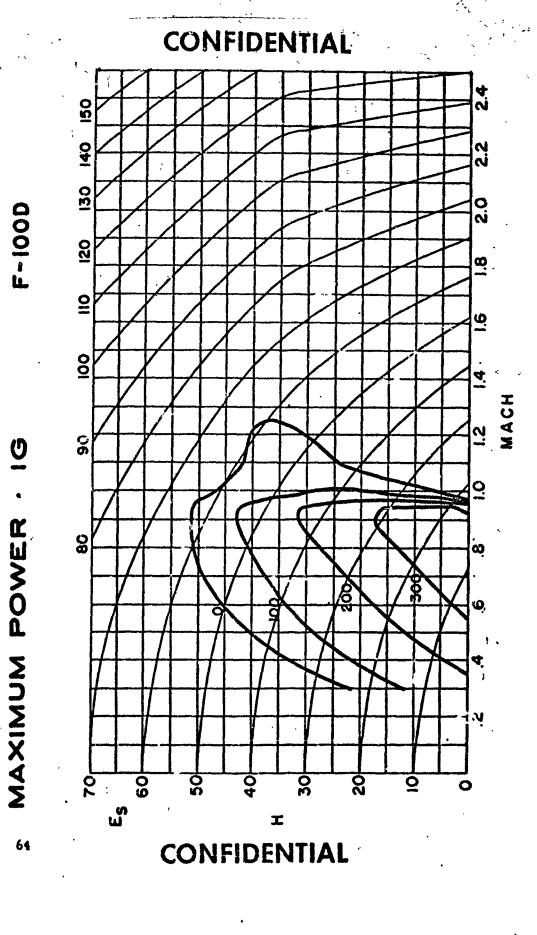
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MILITARY POWER . 15,000"

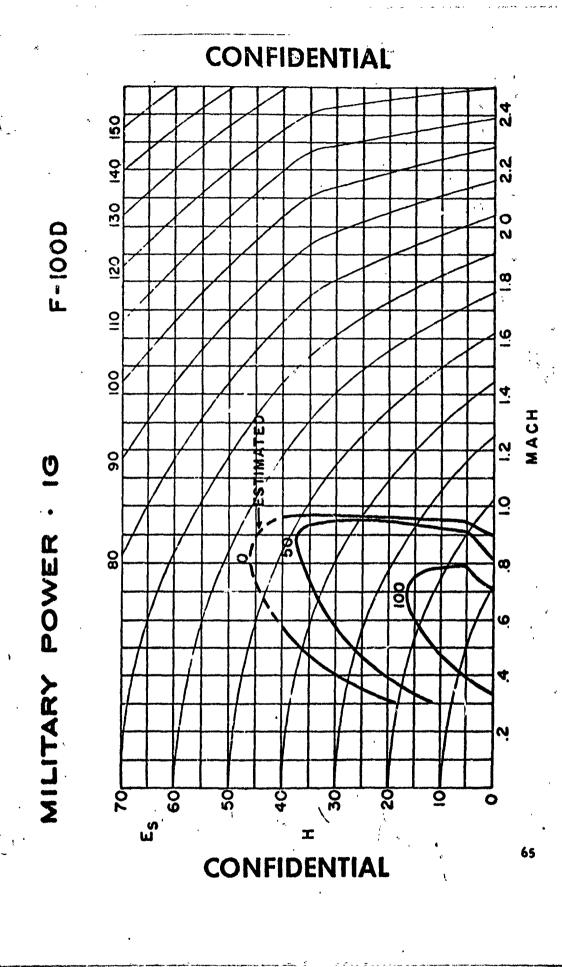
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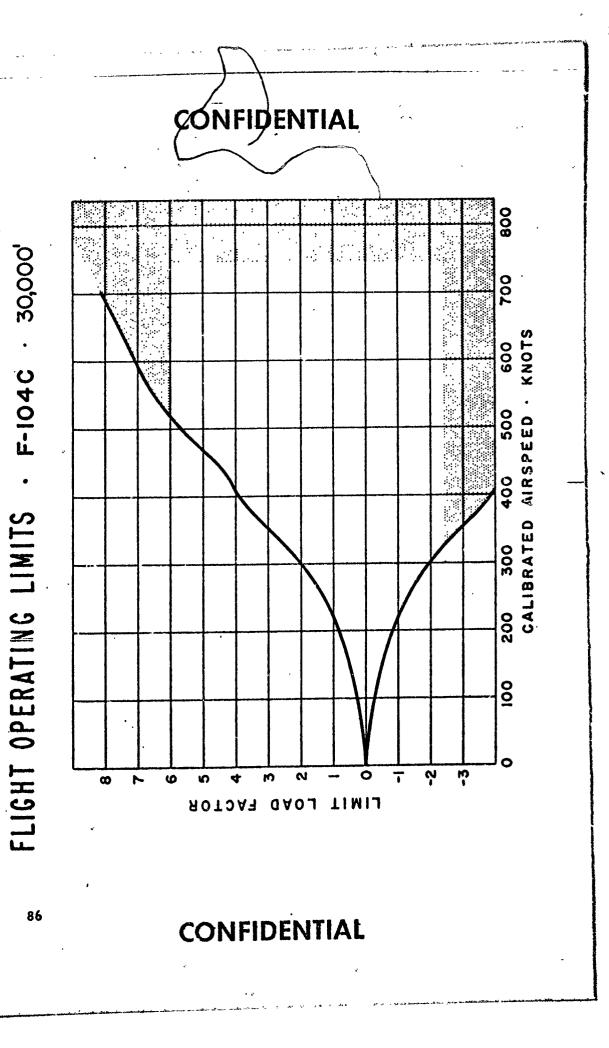


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MAXIMUM POWER · SEA LEVEL

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MAXIMUM POWER - 15,000' 800 1200 400 -800 იო CONFIDENTIAL

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MAXIMUM POWER . 35,000'

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F-104C MILITARY POWER - 15,000' -400 -10001--800

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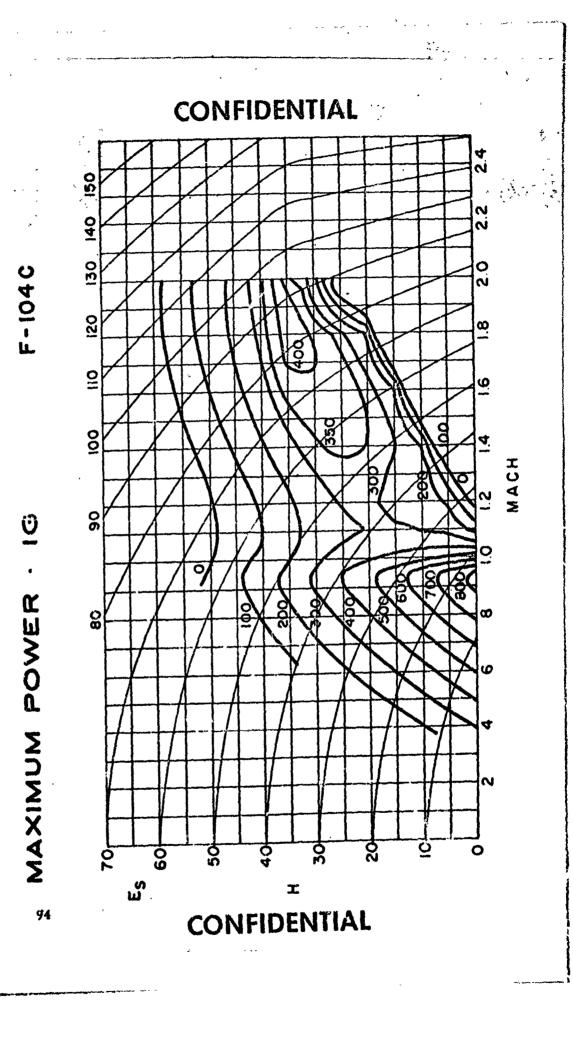
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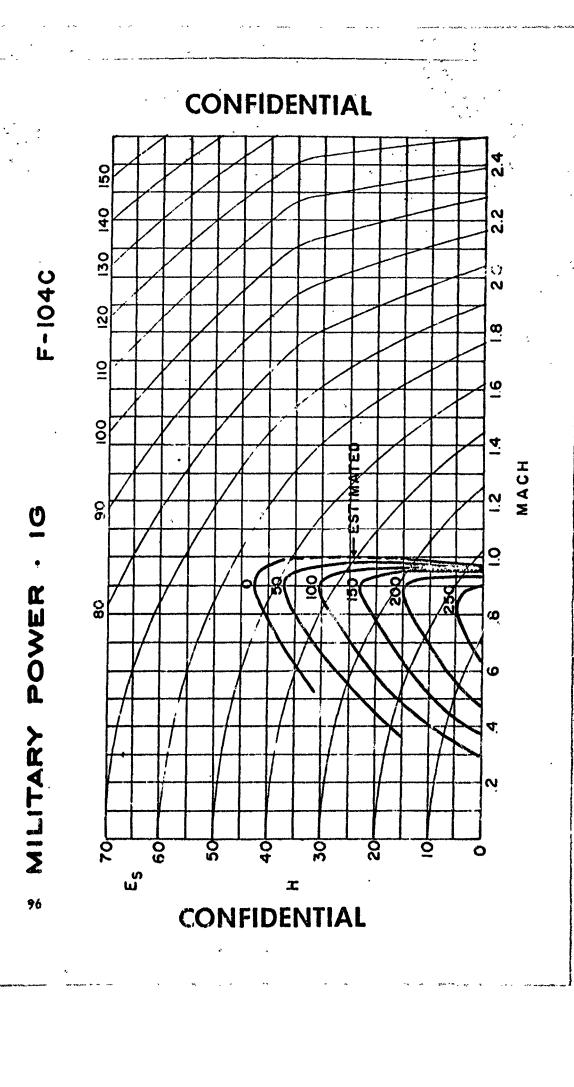
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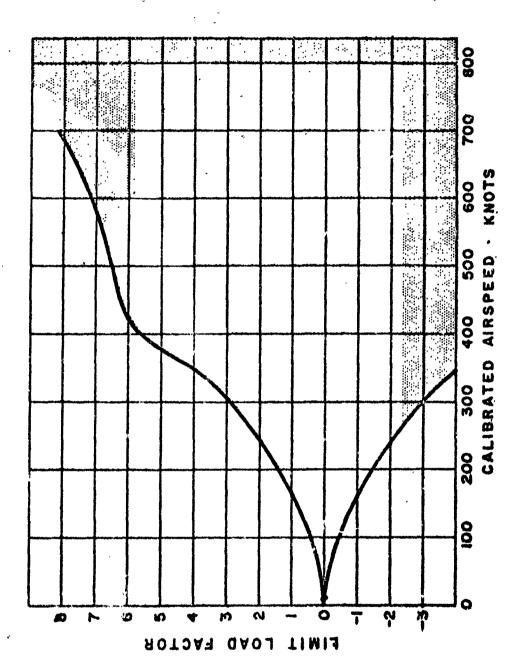
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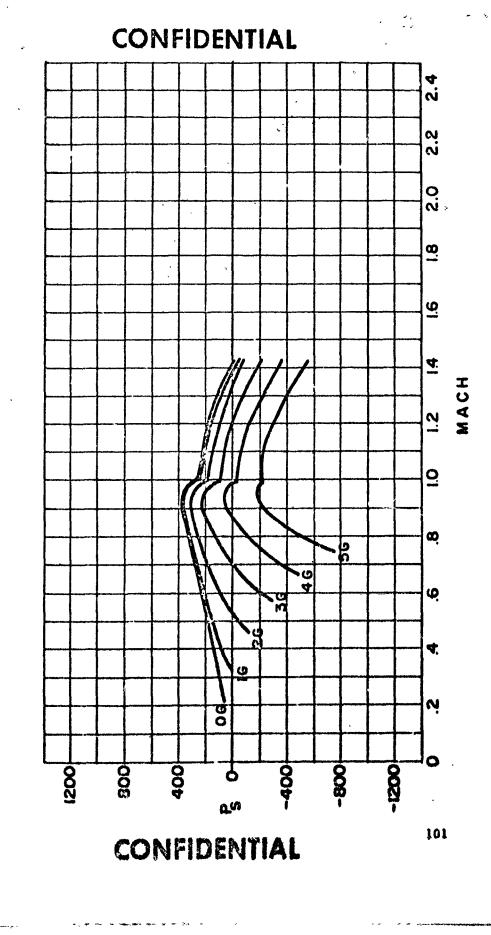
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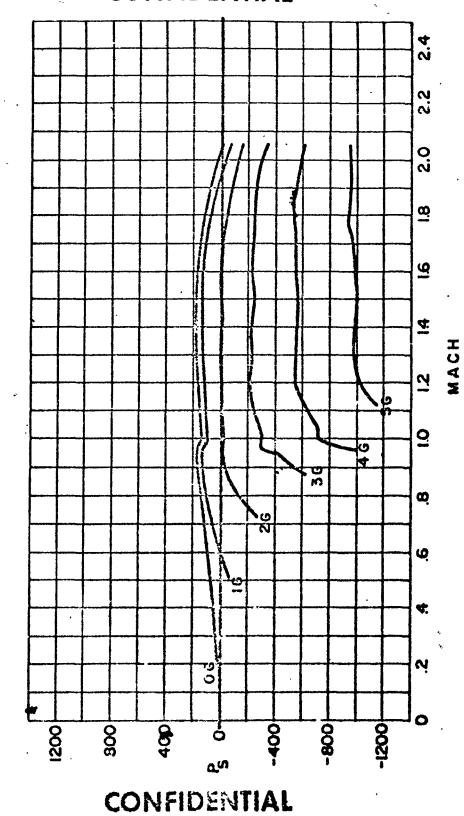
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MAXIMUM POWER - SEA LEVEL

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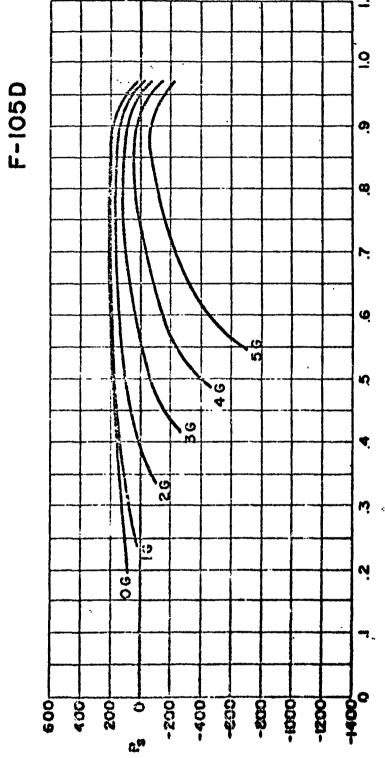
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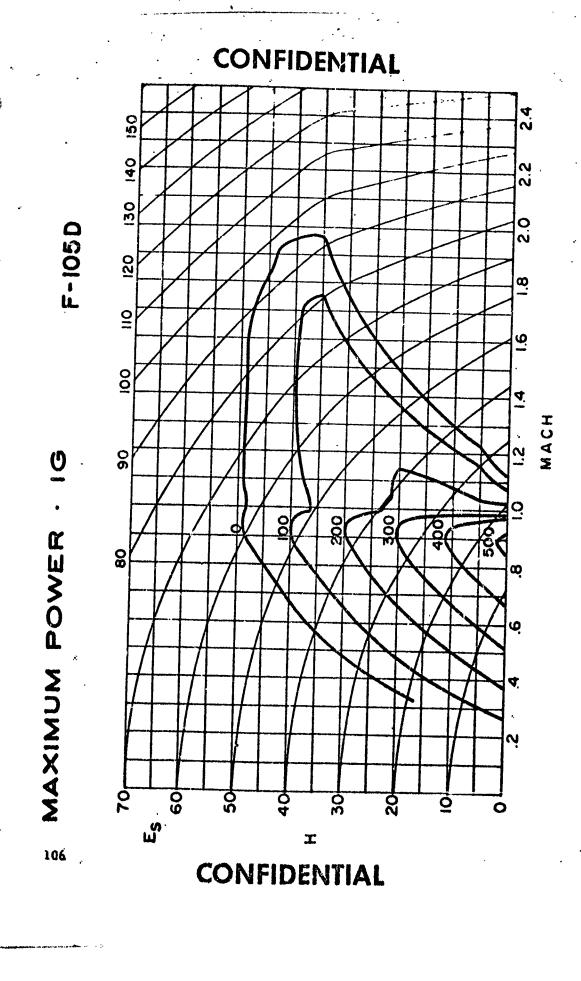
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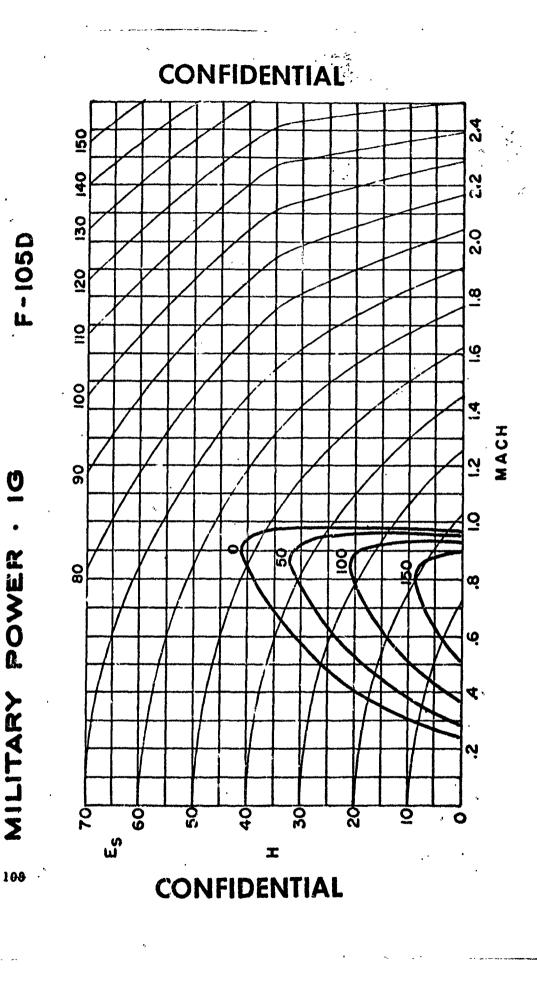
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F-105D MILITARY POWER . 35,000" -1000 -1200 -400 -200 400 008-200 CONFIDENTIAL 105

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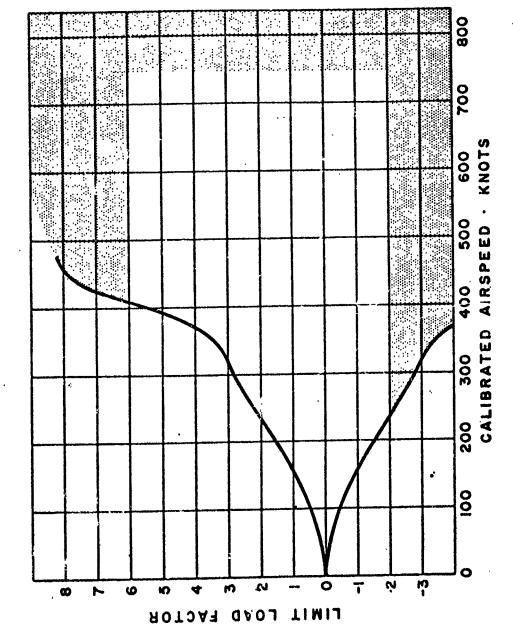
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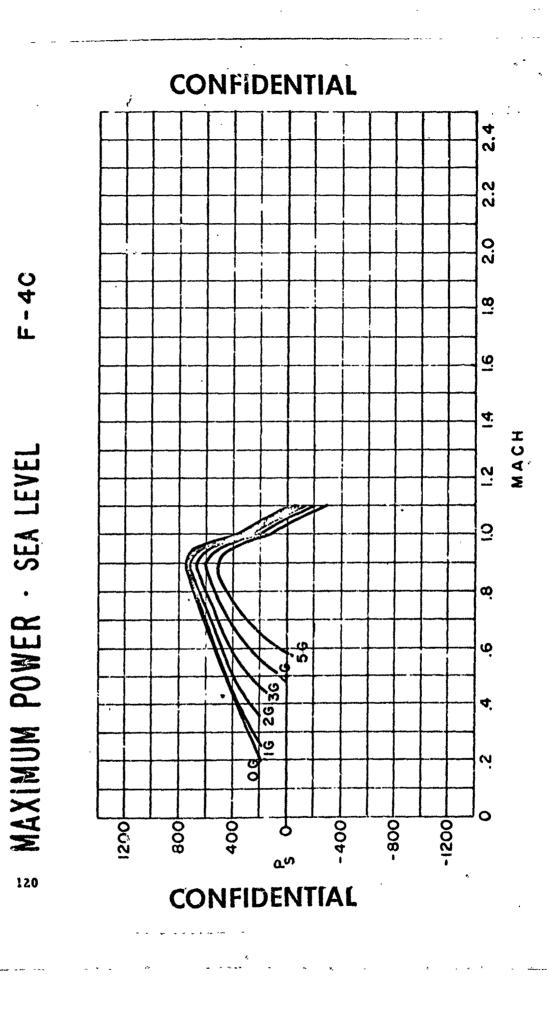


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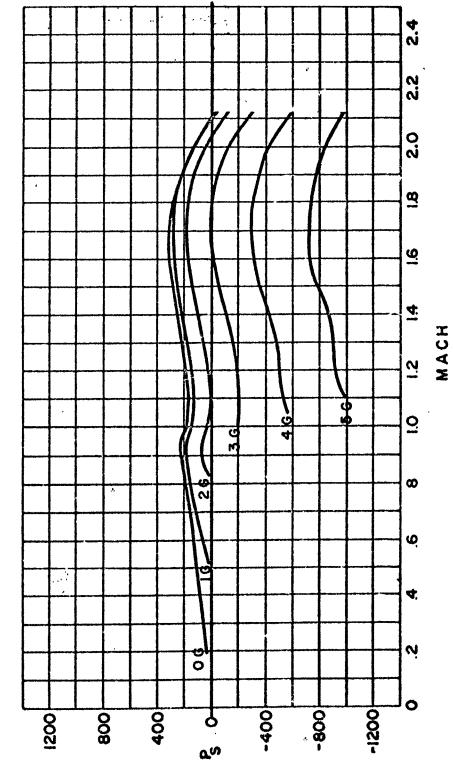


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MAXIMUM POWER . 15,000"



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MAXIMUM POWER · 35,000'

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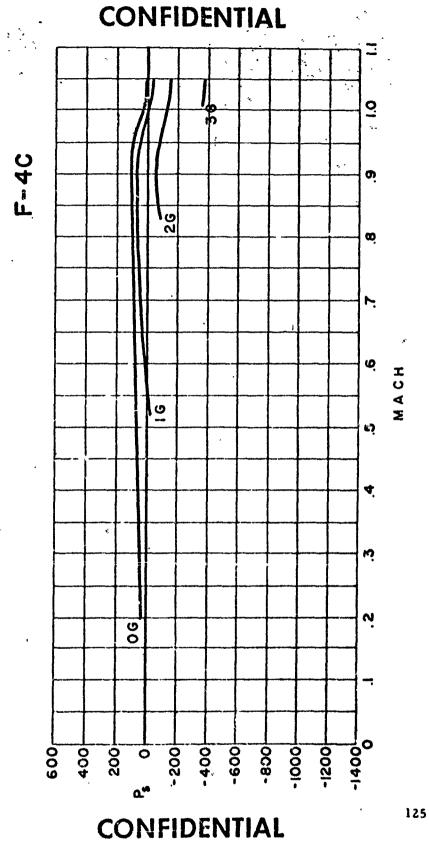
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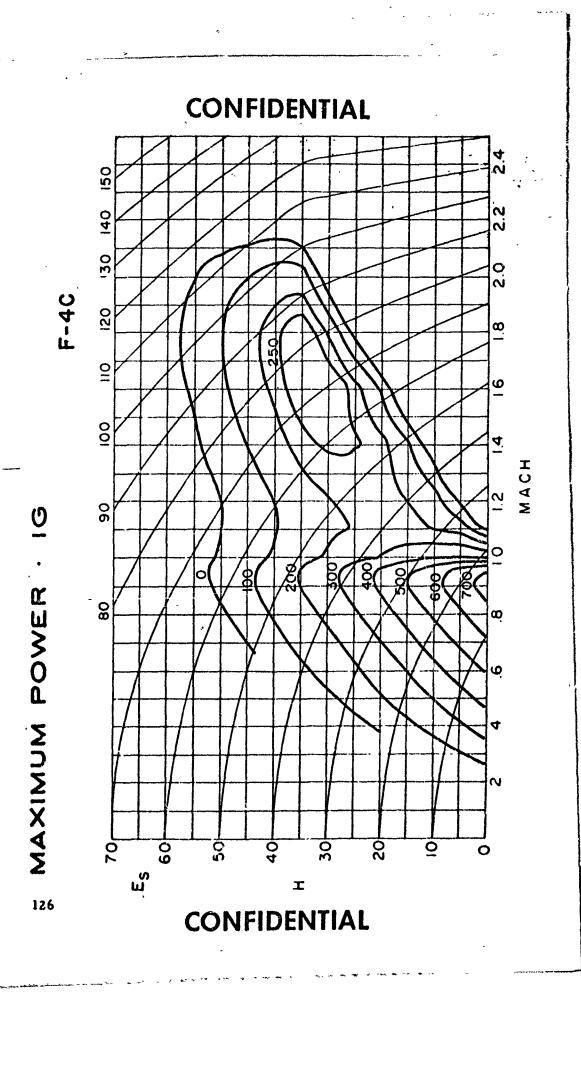
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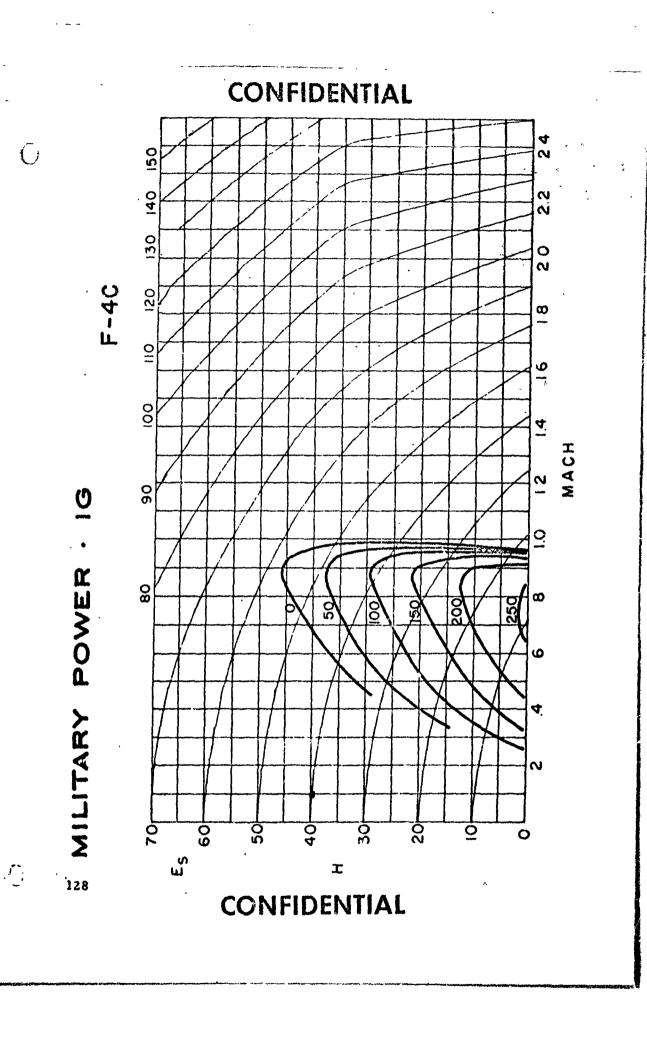
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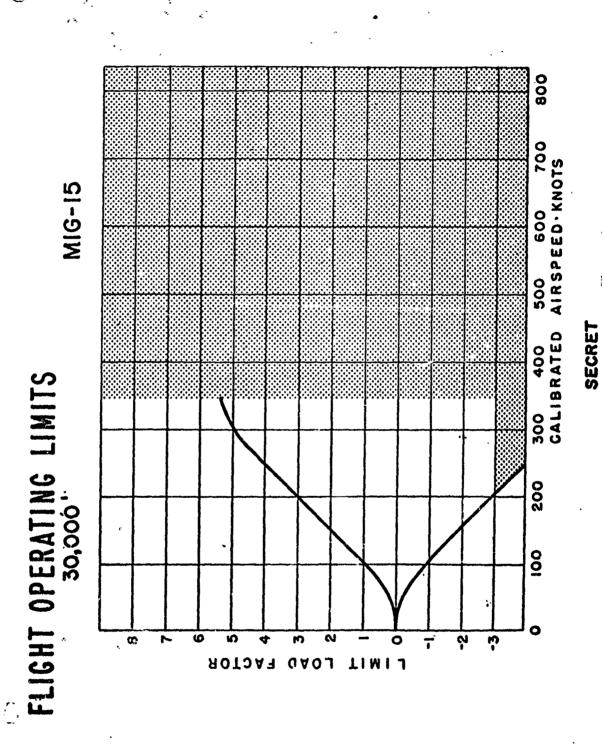
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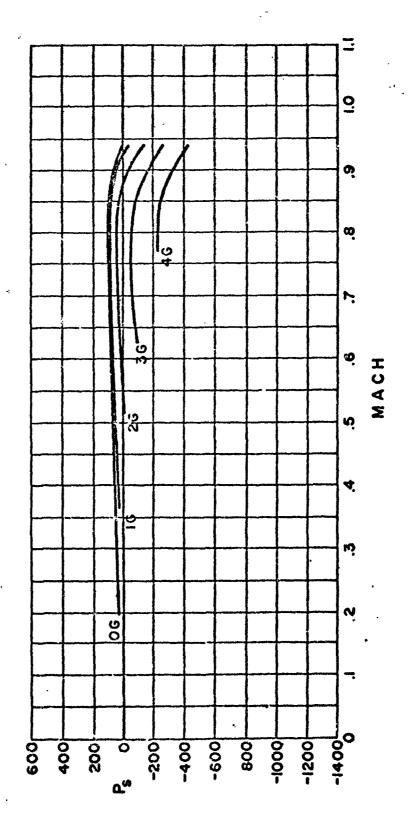
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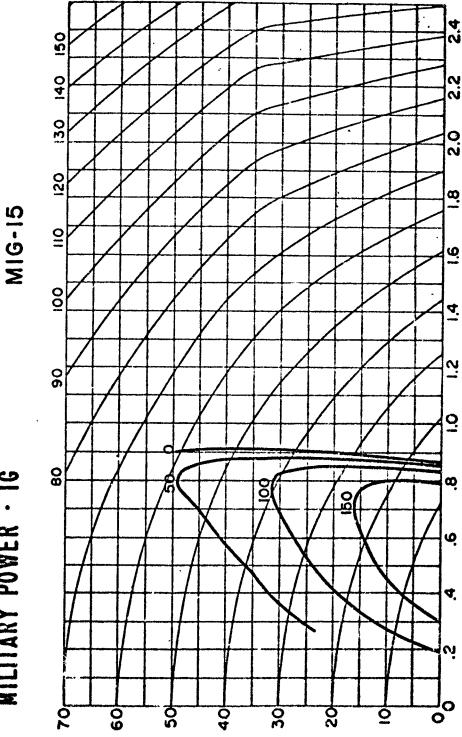
MILITARY POWER - 35,000'

MIG-15



ENERGY RATE MILITARY POWER · 16

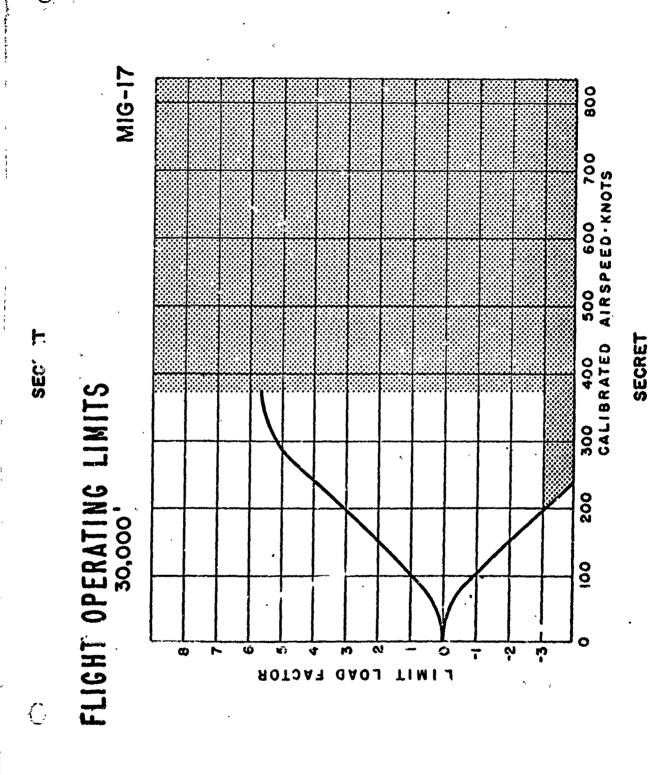
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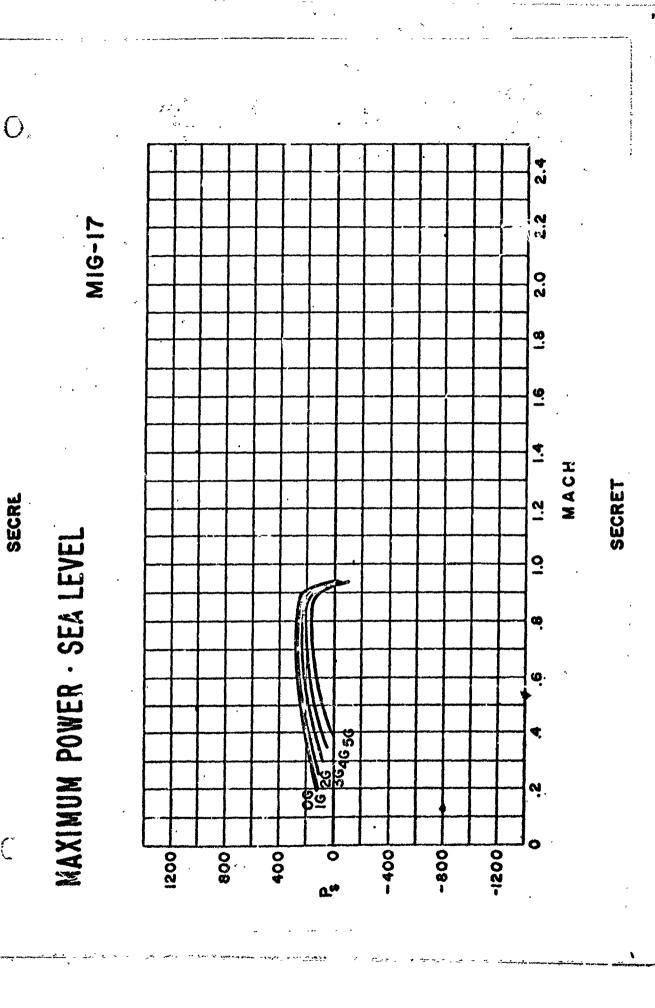


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MIG-17 MACH <u>.</u> -1200 -800 1200 800 400 -400

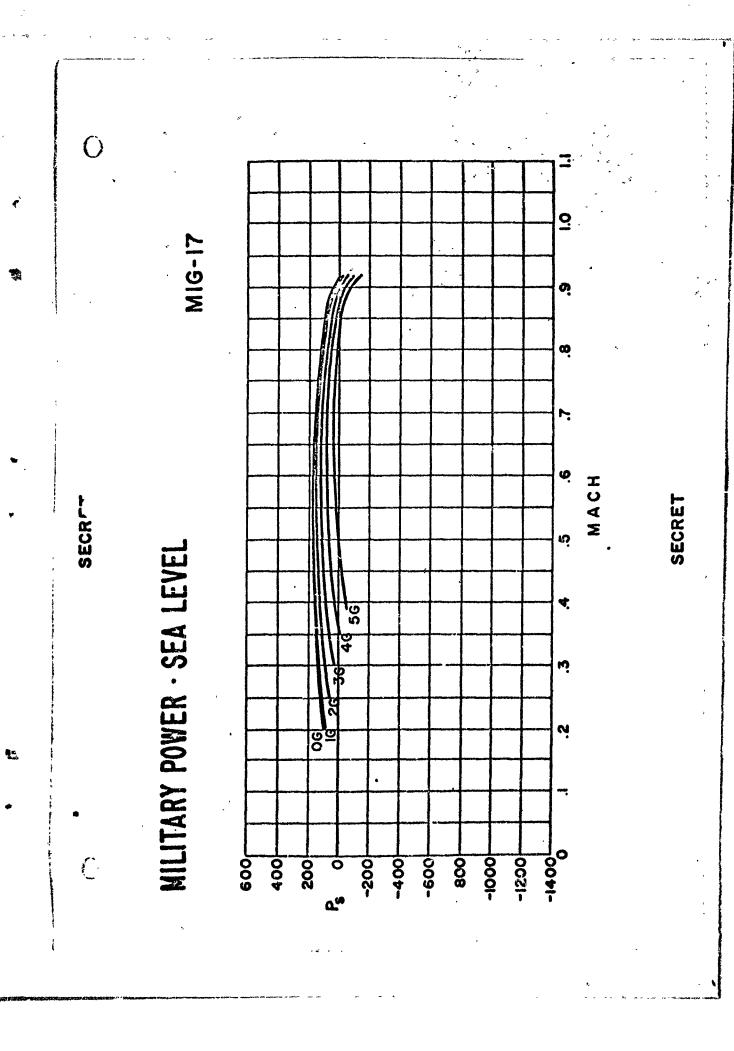
MAXIMUM POWER - 15,000"

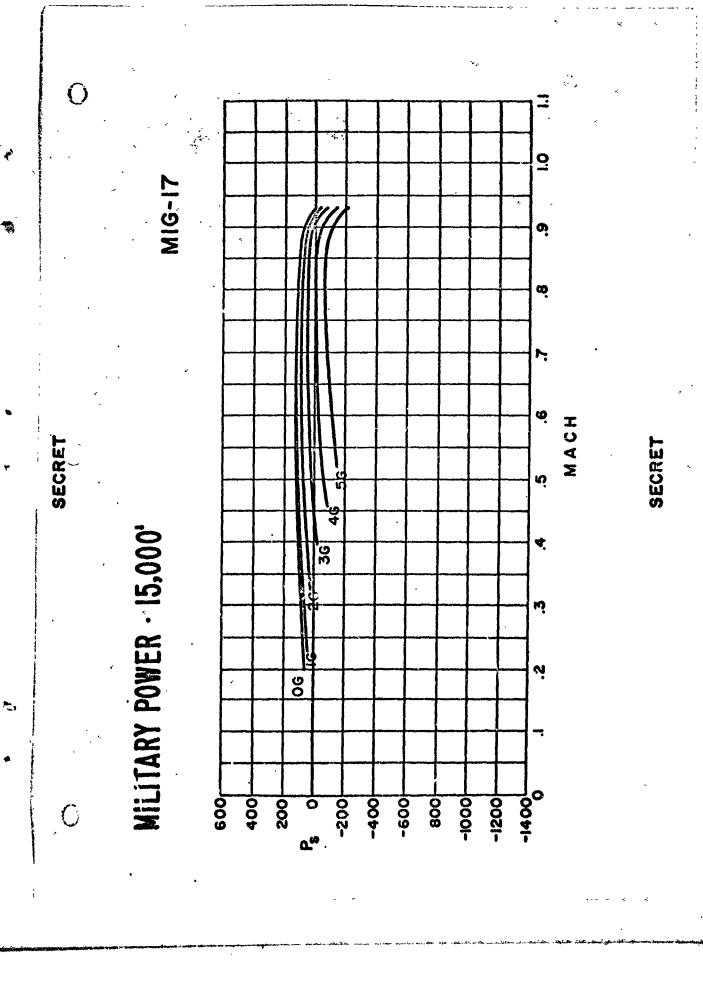
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MAXIMUM POWER - 35,000"

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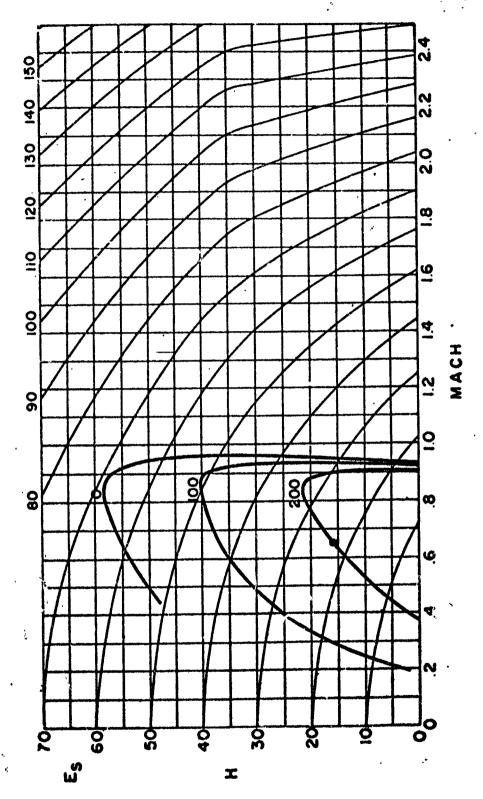


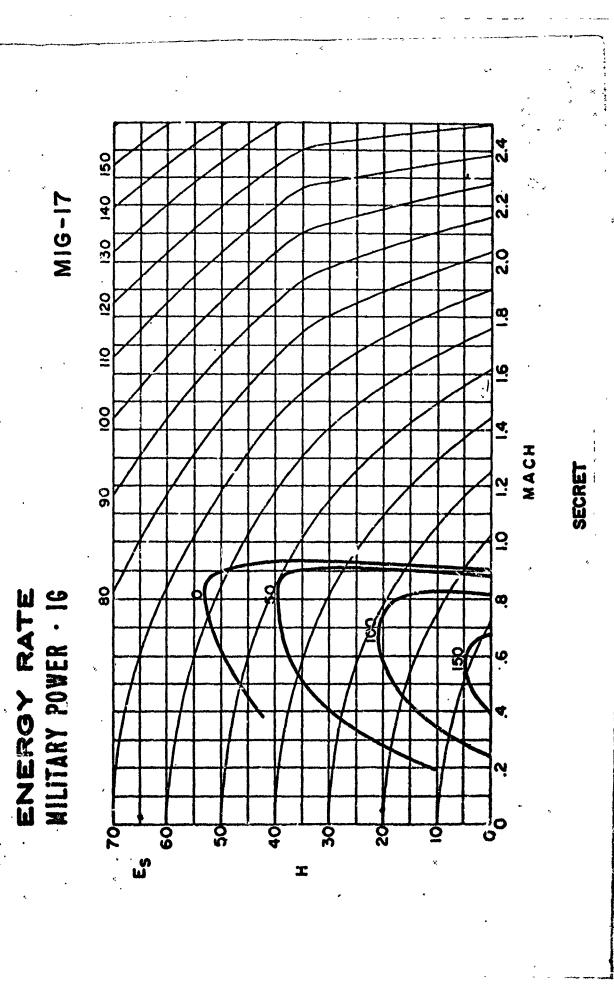


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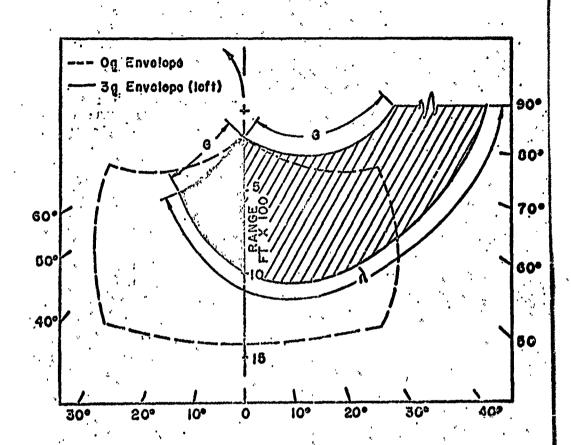
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ANNEX H

AIM-9/B MANEUVERING ENVELOPES

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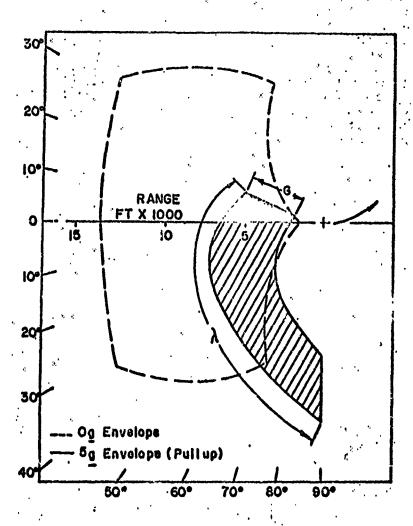
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TOT - 1.0 MACH ATTACK - 1.0 MACH ALTITUDE-35000' TGT MANEUVER-39 LEFT TURN

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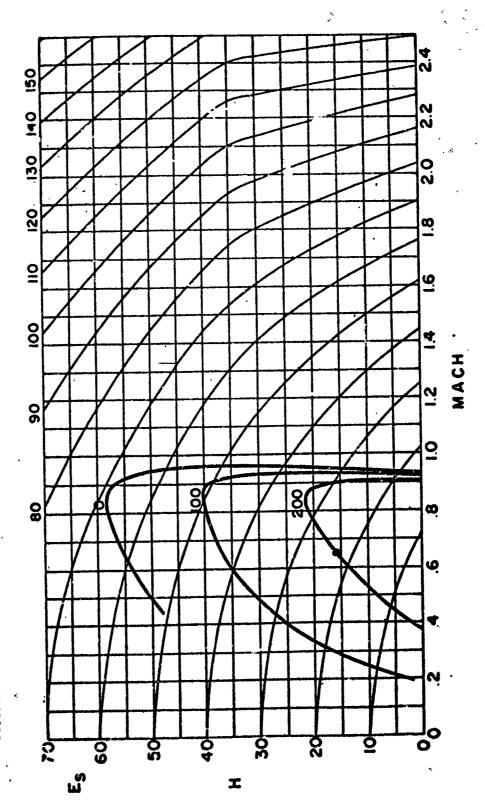
TGT - .9 MACH
ATTACK - .9 MACH
ALTITUDE-35000
TGT MANEUVER - 54 PULL UP

Figure 20 ...

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ENERGY RATE MAXIMUR POWER 16

MIG-17



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INFORMATION





DEPARTMENT OF THE AIR FORCE USAF WEAPONS SCHOOL (ACC) NELLIS AIR FORCE BASE, NEVADA

14 November 1995 40-973 500

MEMORANDUM FOR DTIC

FROM: USAF WS/DCO

4325 Tyndall Ave

Nellis AFB NV 89191-6075

SUBJECT: Release of USAF Weapons School Publication

Publication titled, <u>Final Report: TAC Mission FF 857 Air Combat Tactics Evaluation</u>, AD 372 500 was declassified on 6 October 1995 and is cleared for public release. POC is 1t Lt Angelene Barton at DSN 682-4972.

JAMES D. CANTWELL, Lt Col, USAF

Deputy Commandant

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